THURSDAY, JANUARY 10, 1878

THE SALARIES OF THE OFFICERS IN THE BRITISH MUSEUM

THE inadequacy of the salaries of the officers of the British Museum has long been a standing grievance. It is manifestly impossible to give any valid reasons why the literary and scientific men of this great national establishment should not receive emoluments at least equal to those granted in the ordinary branches of the Civil Service. The obstinacy of the trustees in clinging to obsolete principles of priority, and in endeavouring to keep entirely in their own hands the right of nomination to all the more important posts, has, no doubt, been the main cause why the Treasury have until recently refused to do justice to a most meritorious and ill-treated branch of the public service. From the "Correspondence between the Trustees of the British Museum and the Treasury," which has lately been issued as a Parliamentary Paper, we are glad to find that in this instance, as on former occasions, the present Ministry has been induced to do justice where their predecessors in office have persistently ignored righteous claims. After a long correspondence, commenced in May, 1876, and extending over some fifteen months, it seems to have been finally settled that the salaries of the keepers of the various departments shall be raised to 750*l.* per annum after five years' service, instead of stopping at 600*l.*, the former limit, and that the salaries of the assistant-keepers shall rise to 600*l.* after five years' service, instead of being restricted to 450*l.* as heretofore. The assistants in the various departments will, in future, be divided into two classes, the first, or upper class, with salaries commencing at 250*l.* per annum, and rising by annual increments of 15*l* to 450*l.*; those of the second, or lower class, commencing at 120*l.*, and rising by increments of 10*l.* to 240*l.* This will create a considerable general improvement in the position of these subordinates, of whom the junior assistants, as they are called, have hitherto commenced at 90*l.*, and the senior assistants have never risen beyond 400*l.* But the trustees have agreed to regard the new second class for the future as an "educational class," from which those persons who show special aptitude for the work of the d fferent departments may be promoted to the first class, whilst those who have no extraordinary abilities must remain content with the maximum salary of the lower class. Another concession that the trustees have been compelled to make in order to obtain the above-mentioned advantages is a reduction in the number of the assistants of the upper class. The Treasury justly point out to the trustees that the scheme of having a first class of assistants double the number of that of the second class, is "inconsistent with all ordinary classification," and that the comparative numbers of the two classes "ought to be exactly reversed." This the trustees have, as it appears, somewhat unwillingly undertaken to effect, by a gradual reduction of the number of first-class assistants as vacancies occur, and by making all future appointments into the second class, except when "an opportunity occurs of securing the services of a person possessing very special qualifications."

A third point which the trustees "are prepared to reconsider" is the number of keeperships, now amounting to thirteen, and in order that the Treasury may have greater control in this matter, they have undertaken not to fill up any keepership which may hereafter become vacant, "without the previous concurrence of the Treasury." A still more important proposal made by the Treasury and "conceded by the trustees," is that the position of keeper should be considered as a "staff appointment, to which no officer within the Museum should have any right of succession by seniority." This "concession" will, we trust, do away with the practice of putting round men into square holes, in order to obtain for them an additional salary, which in former years has, we fear, been followed in some instances at the British Museum.

One remaining point, which has much exercised the well-known economy of the Secretary of the Treasury, we are pleased to see he has been obliged to give up. It was proposed that the keepers who occupy the residences attached to the British Museum ought to give up a certain portion of their salaries in lieu of rent. In reply to this ingenious suggestion, the trustees very justly urge that those keepers who reside on the premises have important duties to perform, in having to take in turn the general charge of the whole museum under the principal librarian, for which the accommodation of a residence is no more than a fair equivalent. This contention was ultimately allowed to prevail, and on the whole, we think, there is every reason to be grateful to the Government for the improvements effected by the new scheme in the position of the *employés* at the British Museum. Even in these hard times it cannot be said that a place of 750*l.* per annum with a good residence attached and a pension in future when work is no longer possible, is not such a prospect as may well attract some of the cleverest youths of the period who have a leaning towards literature or science to seek the place of "junior assistant" in the British Museum.

JULES VERNE

Hector Servadac, or the Career of a Comet.—From the Earth to the Moon.—Around the Moon.—Twenty Thousand Leagues under the Sea.—Around the World in Eighty Days.—The Fur Country.—A Winter amid the Ice, &c., &c. (London: Sampson Low and Co.)

THESE remarkable works, which we owe to the genius of Jules Verne, the first-named being that which has last appeared, are well deserving of notice at our hands, for in the author we have a science teacher of a new kind. He has forsaken the beaten track, *bien entendu*; but acknowledging in him a travelled Frenchman with a keen eye and vivid imagination—and no slight knowledge of the elements of science—we do not see how he could have more usefully employed his talents. He will at once forgive us for saying that when we compare his romances of the ordinary type, such as "Martin Paz," with those we have given above, we think that he, as well as his readers, is to be congratulated upon the new line he has opened out.

There have been many books before his time in which the interest has centred in some vast convulsion of nature, or in nature generally being put out of joint, but in these

there has been no attempt made to reach the *vraisemblable;* indeed in most cases there has not been sufficient knowledge on the part of the author to connect his catastrophe either with any law or the breaking of one. But with Jules Verne for once grant the possibility of his chief incident, and all the surroundings are *secundem artem.* The time at which the projectile was to be shot out of the columbiad towards the moon was correctly fixed on true astronomical grounds, and the boy who follows its flight will have a more concrete idea of, and interest in, what gravity is and does, possibly, than if he were to read half-a-dozen text-books in the ordinary way. Once grant the submarine vessel and the use made of electricity, and the various scenes through which the strange ship passes are sketched by no 'prentice hand. To take the most extreme case, if it be possible to imagine one in such a connection—Algeria torn from the earth by a comet and started on an orbit of its own; the astronomical phenomena have been most carefully thought out, and children of larger growth will, if they choose, find much to learn as well as to amuse them. Indeed it is very rare that one finds our author tripping in such matters, although he does sometimes. One case that occurs to us is when, in the "Fur Country," he refers to the midnight sun touching the edges of the *western* horizon without dipping beneath it; and even this may be due to the translator, for we have not the original French edition to refer to.

Thus much premised let us see how, in "Hector Servadac," his last work, the author attempts, as part of his task, to inculcate scientific truths, remarking that his plot is carefully kept out of view till the end of the volume. He and his faithful servant are stunned by a crash, in which the earth groaned as if the whole framework of the globe were ruptured, while the sea and air became one, and both glowed in a radiance intenser than the effulgence of the northern lights. In the midst of a gigantic earthquake-wave he found the moon's disc becoming much larger than it was before, and a new blazing star appearing suddenly in the firmament. Strange to say watches, which are not stopped, mark two as the sun rises in the west! Next point. Their respiration became more forced and rapid, like that of a mountaineer when he has reached an altitude where the pressure of the circumambient air has become reduced; when they jump they fly. The horizon is contracted. There are more surprises: a strange body (the retreating earth) seems to contend in splendour with the sun; but the true condition of affairs has not revealed itself yet, for he is anxious to go and look for his fellow-men; *en attendant,* however, they must eat.

"'By jingo!' he exclaimed, 'this is a precious hot fire.' Servadac reflected. In a few minutes he said:—

"'It cannot be that the fire is hotter, the peculiarity must be in the water.'

"And, taking down a centigrade thermometer which he had hung upon the wall, he plunged it into the skillet. Instead of 100°, he found that the instrument registered only 66°.

"'Take my advice, Ben Zoof,' he said; 'leave your eggs in the saucepan a good quarter of an hour.'"

So much for the careful treatment of the first forty pages. At last the truth dawns upon Hector, and he finds others on the newly torn-off fragment, including even the very astronomer who predicted the comet. A new point in favour of the metric system is here introduced; for our astronomer, anxious to determine the density and mass of *Gallia,* as the fragment had now been named (this is more pardonable than Gallium), finds that not only the metre of the archives, but all other measures whatever had disappeared. He shows that—

10 5-franc pieces	37 mm.	in diameter
10 2-franc	,, 27 mm.	,,
20 50-cent.	,, 18 mm.	,,

exactly make a metre.

A German Jew (M. Verne has his ideas of the different nationalities) is made to lend this sum at an enormous rate of interest, and the experiment proceeds.

"By the appointed time the engineer had finished his task, and with all due care had prepared a cubic decimetre of the material of the comet.

"'Now, gentlemen,' said the Prof. Rosette, 'we are in a position to complete our calculations; we can now arrive at Gallia's attraction, density, and mass.'

"Every one gave him their complete attention.

"'Before I proceed,' he resumed, 'I must recall to your minds Newton's general law, "that the attraction of two bodies is directly proportional to the product of their masses, and inversely proportional to the square of their distances."'

"'Yes, then,' continued the professor, 'keep——"

"'Yes,' said Servadac; 'we remember that.'

"'Well, then,' continued the professor, 'keep it in mind for a few minutes now. Look here! In this bag are forty five-franc pieces—altogether they weigh exactly a kilogramme, by which I mean that if we were on the earth, and I were to hang the bag on the hook of the steel yard, the indicator on the dial would register one kilogramme; this is clear enough, I suppose?'

"As he spoke the professor designedly kept his eyes fixed upon Ben Zoof. He was avowedly following the example of Arago, who was accustomed always in lecturing to watch the countenance of the least intelligent of his audience, and when he felt he had made his meaning clear to him, be concluded that he must have succeeded with all the rest. In this case, however, it was technical ignorance, rather than any lack of intelligence, that justified the selection of the object of this special attention.

"Satisfied with his scrutiny of Ben Zoof's face, the professor went on:—

"'And now, gentlemen, we have to see what these coins weigh here upon Gallia.'

"He suspended the money bag to the hook; the needle oscillated, and stopped.

"'Read it off!' he said.

"The weight registered was one hundred and thirty-three grammes.

"'There, gentlemen, one hundred and thirty-three grammes! Less than one-seventh of a kilogramme! You see, consequently, that the force of gravity here on Gallia is not one-seventh of what it is upon the earth!'

"'Interesting!' cried Servadac, 'most interesting But let us go on and compute the mass.'

"'No, captain, the density first,' said Rosette.

"'Certainly,' said the lieutenant; 'for, as we already know the volume, we can determine the mass as soon as we have ascertained the density.'

"The professor took up the cube of rock.

"'You know what this is,' he went on to say. 'You know, gentlemen, that the block is a cube hewn from the substance of which everywhere, all throughout your

[1] "On this subject an amusing anecdote is related by the illustrious astronomer himself. One day, just after he had been alluding to this, as his usual habit, a young man entered the room, and feeling sure the lecturer knew him well, saluted him accordingly. 'I regret I have not the pleasure of your acquaintance,' said M. Arago. 'You surprise me,' replied the young student. 'Not only am I most regular in my attendance at your lectures, but you never take your eyes off me from the beginning to the end.'"

voyage of circumnavigation, you found Gallia to be composed—a substance to which your geological attainments did not suffice to assign a name.'

"The professor took the cube, and, on attaching it to the hook of the steel yard, found that its apparent weight was one kilogramme, and four hundred and thirty grammes.

"'Here it is, gentlemen; one kilogramme, four hundred and thirty grammes. Multiply by seven; the product is, as nearly as possible, ten kilogrammes. What, therefore, is our conclusion? Why, that the density of Gallia is just about double the density of the earth; which we know is only five kilogrammes to a cubic decimetre. Had it not been for this greater density, the attraction of Gallia would only have been one-fifteenth instead of one-seventh of the terrestrial attraction.'

"The professor could not refrain from exhibiting his gratification that, however inferior in volume, in density, at least, his comet had the advantage over the earth."

We have given this long extract to show the pleasant way in which, in this latest form of French light literature, amusement is combined with instruction. It would not be fair to the book to say more of the plot or of the *dénouement*.

We have dwelt especially upon Jules Verne's latest book, but equal praise must be given him for all those we have named. A boy, for instance, who had read how the frozen island in the "Fur Country" was kept together by Dr. Black's device, would at once understand the *rationale* of Pictet's and Cailletet's recent splendid work, to say nothing of the physical geography he would have gradually absorbed in following the strange adventures recounted in that volume.

We are glad to have such books to recommend for boys' and girls' reading. Many young people, we are sure, will be set thirsting for more solid information.

OUR BOOK SHELF

The Geometry of Compasses; or, Problems Resolved by the mere Description of Circles, and "the Use of Coloured Diagrams and Symbols." By Oliver Byrne. (London: Crosby Lockwood and Co., 1877.)

THIS is only our old friend, "La Geometria del Compasso di Lorenzo Mascheroni" (Paris, 1797), decked out in the manner we have indicated in the quoted portion of the title. The order of sequence has been departed from, but this is not a material point. The constructions are the same and the proofs the same with, we believe, one exception, in which case we give the preference for simplicity to Mr. Byrne.

There are twenty problems, which are in most cases given in duplicate, first construction and figure in colours, then proof and unadorned figure on the next two pages.

The merits and nature of Mascheroni's work are well known; hence the present work, for reasons given above, is good. But we cannot call this Mr. Byrne's book. Problem XX., which is the last, is an elegant construction for dividing the circumference into seven equal parts by plane geometry. But for this the compiler is indebted to an able mathematician, Dr. Matthew Collins. The book is very neatly and correctly got up, and for frontispiece has a hand with a pair of compasses transferring a given length.

Proceedings of the American Philosophical Society. Vol. xvi., No. 99. January to May, 1877.

PROF. COPE has several noteworthy papers in this part: one, on the Batrachia of the coal-measures of Ohio, describes the new genus, Ichthycanthus, and the new species of Leptophractus and Tuditanus. He also describes remains of a Dinosaurian from the trias of Utah; the humerus is one of the longest, and distally the most contracted known in the group. These remains are the first discovered fossils in the triassic beds of the Rocky Mountain regions. Another valuable paper is on the brain of Coryphodon. One of the longest contributions will be much esteemed by geologists, viz., Mr. Ashburner's measured section of the palæozoic rocks of Central Pennsylvania (Huntingdon County), a section extending vertically through 18,394 feet. A very valuable series of physiological experiments is recorded in a paper by F. L. Haynes, on the asserted antagonism between nicotin and strychnia. Philology is well represented by a paper on the Timucua language, by Mr. A. S. Gatschet; this language, formerly spoken in Florida, appears to be the oldest within the American Union of which writings of some extent are preserved.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.]

The Radiometer and its Lessons

WITH reference to the controversy between Mr. Stoney and Mr. Osborne Reynolds about the laws of the conduction of heat in gases, it seems desirable to call the latter gentleman's attention to the fact that neither Clausius' nor Clerk Maxwell's investigations, as published in the *Philosophical Magazine*, affect the controversy between them.

The latter, in his papers in the *Philosophical Magazine*, vol. xxxv., lays particular stress upon the fact that he supposes the motions of the molecules to be uniformly distributed in every direction. He says, however, on page 188: "When one gas is diffusing into another, *or when heat is being conducted through a gas*, the distribution of velocities will be different in the positive and negative directions instead of being symmetrical, as in the case we have considered." From this theory of the uniform distribution of velocities he deduces the formula (29), (31), and (32), as he numbers them, and to which he subsequently refers. On page 214 he gets an equation (143) which represents the transference of heat through the medium, and says: "The second term contains quantities of four dimensions in $\xi\ \eta\ \zeta$, *whose value will depend upon the distribution of velocity* among the molecules. *If* the distribution of velocity is that which we have proved to exist when the system has no external forces acting on it, and when it has arrived at its final state we shall have by equations (29), (31), (32) . . ." certain results from which he deduces his equation for the conduction of heat in gases.

When he says "has arrived at its final state" it is evident from his reference to the equations that he means the state of a gas in which neither diffusion nor conduction of heat nor currents of any kind are going on. It will thus be seen that his final result is only a first approximation and could not possibly be expected to hold within distances comparable with the mean length of the path of a molecule between two encounters.

Clausius in his paper as translated in the *Philosophical Magazine* for June, 1862, does suppose a distribution of velocity among the molecules of such a kind that the velocity and number of molecules moving in the positive and negative directions is different, but assumes the mean between them to be the same as the number moving in a direction normal to the direction of the transference of heat. This is evident from the fact that what he practically does is to assume that the number of molecules moving in a direction making an angle θ with the direction of transference of heat can be expressed by a formula of the form—

$$n = n_0 (1 + e \cos \theta),$$

for he neglects e^2 throughout his investigation. In this form it is evident that n_0 is the number when $\theta = \frac{\pi}{2}$ and is the mean of the values $n_1 = n_0 (1 + e)$ and $n_2 = n_0 (1 - e)$, which represent the numbers going towards and from the points of high tempera-

ture. From the fact that e^2 enters into the investigation at all it is evident that this is only an approximation to the true distribution. In accordance with this Mr. Stoney has shown conclusively that in a compressed Crookes's layer the number of molecules moving parallel to the direction of the transference of heat is greater than the number of those moving in any direction normal to it, so that the expression Clausius derived from this assumption cannot be considered as expressing the whole state of affairs.

It is remarkable that to this order the expression for the pressure on *any* plane is the same, but Clausius gives another term in his expression for the pressure on a plane normal to the direction of transference of heat to which he attaches, indeed, only an indefinite coefficient because it is of the order e^2, and he was purposely neglecting quantities of that order. He might have prophesied, however, from the existence of such a term that at distances comparable with e a force would be manifested such as Mr. Crookes has since discovered. Now this e is by definition a quantity of the order of the length of the mean path between successive encounters, and hence these terms, varying with e^2 would become of importance at distances comparable with the length of this mean path.

I believe, then, that I have shown that neither Clausius nor Clerk Maxwell have considered the case in dispute between Mr Stoney and Mr. Osborne Reynolds, and that as far as their investigations bear upon it they tend very much to strengthen Mr. Stoney's case. I have also shown that Clausius was on the point of anticipating both Crookes's force and Mr. Stoney's explanation of it. GEO. FRAS. FITZGERALD

Trinity College, Dublin

Prof. Eimer on the Nervous System of Medusæ

SOME of your readers may remember that a few months ago I published in NATURE an abstract of a lecture which I had delivered at the Royal Institution on "The Evolution of Nerves." In this lecture I mainly treated of my recent researches on the nervous system of *Medusæ;* and stated, among other things, that I was the first to publish the observation concerning the paralysing effect of removing the margins of nectocalyces.[1] Within the last few days, however, I have received a communication from Prof. Eimer, of Tübingen, informing me that he has the right to claim priority as regards the publishing of this observation. I therefore send you this note in order that I may rectify the injustice which I previously did to Dr. Eimer in your columns.

The facts of the case are simply these: Dr. Eimer made his observation a few months later than I made mine; but, as he communicated his observation within a few weeks after he had made it to the *Physikalisch-medicinischen Gesellschaft zu Würzburg*, his publication preceded mine. He has therefore the right to claim priority as regards this observation, and also as regards some further physiological experiments by which he followed it up—all of which I have been careful to detail in my Royal Society publications.

So much in justice to Dr. Eimer. In justice to myself I must now explain that, although, since the publication of my Croonian lecture in 1875, I have been aware that Dr. Eimer's work was independent of mine, it is only within the last few days I have learned from him that the publication of his work was prior to mine. The reason of the ambiguity on this head is explained in a newly-published memoir by Dr. Eimer, where it is stated that his previous memoir, having been published in the *Würzburg Verhandlungen* without its proper title-page, the initials "*d. J.*" ("this year"), which occur in the paper itself, refer, not to the date on the volume, but to the year preceding. My prolonged ignorance concerning Dr. Eimer's claim to priority, has, therefore, not been due to any fault on my part; and as in all my previous publications on this subject I have spoken of Dr. Eimer's work as subsequent to my own, I may here add that I think the fact of his having been so long in acquainting me with the true standing of the case, displays a laudable spirit of indifference on his part to the matter of mere priority.

GEORGE J. ROMANES

18, Cornwall Terrace, Regent's Park, N.W.

Mr. Crookes and Eva Fay

AFTER Mr. Cooper's courteous explanation which appeared in last week's NATURE (p. 183), I gladly exonerate him from blame.

[1] I first published this observation in a note to NATURE, which appeared in November, 1874.

To the publication of my letter in the *Banner of Light*, if Mr. Cooper thought it likely to do Eva Fay any good, I have no ground of complaint; but what I did, and do now, protest against, is the unauthorised publication of a lithographed *facsimile* of my letter in such a manner, and with such surroundings, as to leave no doubt that the intention was to throw discredit on my testimony as a trustworthy experimentalist.

I am glad to find that Mr. Cooper was no party to this breach of etiquette, and I willingly withdraw any expressions in my letter in NATURE (vol. xviii. p. 43) which may appear to reflect on him.

As a fitting climax to this controversy, may I request you to publish the subjoined letter from Eva Fay, which appeared in the *Banner of Light* for December 22 last?

London, January 7 WILLIAM CROOKES

"To the Editor of the *Banner of Light*, Boston, U.S., December 22

"I WISH to state a few facts in reference to an article in your paper of December 8, referring to myself, in a letter of Mr. Crookes on Dr. Carpenter's attack.

"First, it is untrue that Mr. Crookes gave me a letter speaking of the spiritualistic nature of my manifestations, and referring to Fellows of the Royal Society. The only letter, to my knowledge, that Mr. Crookes ever wrote regarding my mediumship (with the exception of the one written to Mr. Cooper) appeared in the London *Daily Telegraph*, and other journals, March 11, 1875.

"Second, in reply to Dr. Carpenter's statement that an offer was made by my managers in May, 1875, of an equivalent sum of money for me to 'expose the whole affair,' I will now say to Dr. Carpenter, as I did to my managers, *I have nothing to expose.*

"I am in receipt of a letter, dated November 18, 1877, asking me if I will fix a price to visit England under the title of an 'Exposée,' and show how I am supposed to have hoodwinked members of the Royal Society.

"My reply was as follows:—'As poor as I am, and as clever as I am supposed to be by Dr. Carpenter and others, I am obliged to decline your tempting proposition to replenish my exchequer by attempting impossibilities. I sincerely hope to be able to maintain myself and child in a more honourable occupation.' "ANNIE EVA FAY

"Akron, Ohio, December 10, 1877"

Volcanic Phenomena in Borneo

MR. WALLACE, in his work on the "Geographical Distribution of Animals," has the remark that no volcano, active *or extinct*, is known to exist within the area of the island of Borneo, notwithstanding that it is almost environed by a volcanic belt in full activity at a short distance. In fact, it seems to be generally understood that this vast island now represents, and has continued to represent for long past time, a perfectly quiescent area in so far as manifestations of subterranean energies are concerned. This view is doubtless strictly correct in regard to the existence of any volcanic vent which is now in action, or which has been so within the historical period; but it would be erroneous to deduce from it, as seems natural to do at first sight, the inference that the area is one of entire quiescence, or that it has been so free from volcanic action in any but the most recent times.

Speaking solely with reference to the north-west district, it may be observed that shocks of earthquake have been recorded more than once by credible witnesses during late years, viz., one in June, 1874, a second in June, 1876, and two more in July, 1876. These were recorded the first in Sadong, the three others in Sarâwak. According to native testimony, slight shocks are by no means rare, and a severe one is particularly held in remembrance, which took place seventy or eighty years ago, and was accompanied by "a rain of ashes." Seismometrical observation would probably show that they are very frequent. These shocks seem to indicate that the island is directly affected by the proximity of the volcanic band above referred to.

As for the period of time preceding the historical epoch, there are not wanting signs that this part of Borneo was the theatre of a display of considerable volcanic energy, and it has yet to be shown that its date of activity was anterior to the deposition of the sandstone conglomerate formation of the country, which is, with the exception of very recent deposits, the most modern of the stratified rocks of this part of the island, it having been assigned—I know not with how much truth—to a later tertiary

date on the evidence of the plant-remains found in the coal-seams which are associated with it.

Owing to the difficulty of determining questions of relative superposition in a country so densely clothed with vegetation, and to the insignificant depth of the sections, natural and artificial, which are accessible, coupled with the remarkably disturbed condition of large tracts of the sedimentary rocks—it is not possible to define at present the relations of the igneous to the sedimentary rocks of the district. Nevertheless, such evidence as I have myself been able to collect goes to support the hypothesis that the last outbreak of volcanic activity was posterior in date to all but the more modern deposits of shales, clays, river-gravels, &c., or, in other words, that it preceded more or less immediately, the last submergence of north-west Borneo—though separated from that submergence by a long interval, and possibly being the concomitant of an antecedent elevation of the land.

The traces of this outbreak remain in the existence of thermal springs, two at least of which occur in association with hills of trappean and basaltic rocks; the country in many parts is dotted with hills of basalt, columnar basalt, and felspathic porphyries, and in the intervening lowlands is seamed with dykes of porphyritic, hornblendic, and siliceous rocks; the sedimentary strata are greatly disturbed when the igneous rocks occur, being often upheaved at high angles and much plicated, and locally the sandstones and shales have been metamorphosed; whilst masses of a volcanic-conglomerate (?) are occasionally met with.

Philippine Islands, September 27 A. H. EVERETT

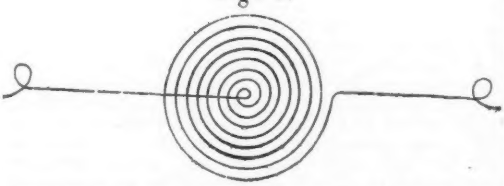
New Form of Telephone

HAVING had the pleasure of listening to Mr. Preece and Prof. Graham Bell explaining that most wonderful invention, the telephone, at the late meeting of the British Association in Plymouth, I endeavoured to obtain the instrument for my own use, and was ultimately successful.

It soon struck me that if the disc or diaphragm whose vibration causes the induced current in the coil of copper wire must be a magnetic substance, and not simply a conductor, then if I could succeed in getting an electro-magnet to vibrate in a similar manner it might be possible to get as powerful a sound.

With this object in view a coil of insulated copper wire was fastened to a card, as shown in Fig. 1.

Fig. 1.



The wire used was No. 28 cotton-covered, and it was sewed to the card with thread.

The iron disc was taken out of one of the telephones, and the coil-diaphragm put in its place through which a current was passed from a single Bunsen cell. On making connection with the other telephone, talking, singing, and whistling were heard distinctly at both.

Various coils have since been tried both with thicker and also thinner wire, but as yet the results have not been as good as when the iron disc is used.

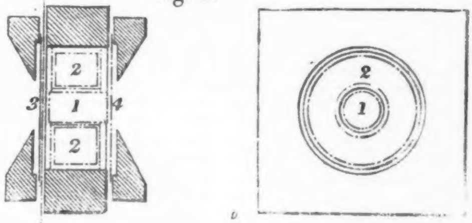
When two such coils are used, one superposed on the other, the loudness of the sound transmitted is increased to some extent. The same result is produced by adding another Bunsen cell. With a Daniell's cell the sound is very feeble. When a coil is placed in each telephone the result is rather unsatisfactory as yet.

It has also been noticed that a simple conductor as a coil of copper wire also transmits sound but very faintly.

A small apparatus (Fig. 2) has been made to show the effects above described. A piece of wood about three inches square and about one inch thick has a hole bored through it about two inches in diameter. A reel (2) containing about 250 yards of silk-covered copper wire is placed in the hole with a piece of soft iron about half an inch in diameter as axis (1).

A coil-diaphragm (3) is placed across one end of the hole at a very short distance from the soft iron core, and is covered by a mouth-piece. Across the other end of the hole at a similar distance from the core is placed a thin iron disc (4) which is also covered by a mouth-piece. On a current being passed through the coil-diaphragm this apparatus acts as a telephone, and messages can be sent from either side of it.

Fig. 2.



1. Iron core. 2. Coil of wire. 3. Coil diaphragm. 4. Iron disc.

The iron disc and core may be removed, and the coil-diaphragm alone acts in an exactly similar manner.

The above are the results of some experiments which have occupied my spare time lately, and not having seen anything similar published I forward them to you as they are rather interesting. The whole of the experiments have been conducted with the aid of my friend, Mr. G. B. Nicoll, who has also made many important suggestions. JAMES M. ROMANIS

Shooting Stars

THE number of shooting stars seen here during the last six months (July to December) is 2,259 in 168 hours of watching. This number includes 385 Perseids observed between August 3 and 16. Of the remaining 1,874 1,028 were seen during seventy-five hours in the mornings and 846 during ninety-three hours in the evenings. After making certain allowances for time spent in registering the paths (and omitting the Perseids), the horary numbers appear to have been as follows:—

16·4 A.M., 10·9 P.M., 13·4 A.M. and P.M.

From these figures I estimate that the aggregate number of shooting-stars as bright as, or brighter than, 5th mags., which entered the earth's atmosphere in this particular part of the world by night and day during the last six months, was about 236,700. The horary number has already been mentioned as 13·4 for one observer. Now a single pair of eyes certainly cannot command more than a fourth part of the visible sky, so that we must adopt 53·6 as the horary rate over the whole sky. From this we readily deduce the diurnal number as 1286·4, and the aggregate for the six months, 236,697·6 as above.

When it is further considered that the average height of ordinary shooting-stars is only about seventy miles, and that therefore observers at widely distant stations must each see a distinct set altogether, we are able to form some remote idea of the vast number that enter our atmosphere every day.

Bristol, December 26, 1877 W. F. DENNING

Gentiana asclepiadea and Bees

THIS gentian is very abundant on the mountain slopes round Engelberg, as visitors to that part of Switzerland well know. As I was botanising in the neighbourhood, in the autumn of this year, I observed that most of the flowers were pierced with a round hole at the base. Presently I saw a bee come to one of the pierced flowers, and thrust in its proboscis in search of honey. The flowers of this beautiful, sweet-smelling gentian are long and funnel-shaped, and very contracted at the base, and, as the bee that visited it was a "fair large" one, like Sir Torre's diamond, and not of the narrow hive-bee type, it could not possibly have effected its purpose by entering the flower in the usual way at the top, and had no doubt resorted to this method of extracting the honey. I only saw this one kind of bee visit the flowers, but I saw many of them at work, and all acted in the same way. One of them came to some of the flowers, which I had gathered, as I held them in my hand. I cannot say that I saw a single flower actually pierced by a bee; the day was warm, even for Engelberg, and the bees were very

quick in their movements, which increased the difficulty of observation, but that the bees themselves were the agents, in making the holes, there can be no reason to doubt.

Highfield, Gainsborough, December 21 F. M. BURTON

Photography Foreshadowed

THE first prophetic allusion to the photographic art, the discovery of which was to take place eighteen centuries later, is perhaps found in the story of the miraculous occurrence told in the life of St. Veronica.

The second instance is about the year 1690; but intermediate instances may probably be found. I extract from the works of Fénelon[1] the following passage from an imaginary voyage in 1690:—"There was no painter in the country, but when anyone wished to have the portrait of a friend, a beautiful landscape, or a *tableau* which represented any other object, he put water in large basins of gold or silver; then placed this water opposite the object he wished to paint. Soon the water congealing became like a looking-glass, in which the image of that object remained ineffaceable; and it was a picture as faithful as the brightest mirrors." One could wish that the author had entered into detail as to the manner "of placing this water opposite the objects he wished to paint."

The third instance is about 1760, that is seventy years later, and seventy-nine years before 1839, the date of Daguerre's discovery. It is reported[2] by Ed. Fournier, who extracted from what he calls "un assez mauvais livre," written by a certain Tiphaigne de la Roche[3], the entire passage, extremely curious, but rather long. This passage contains many details. The "water" of Fénelon is replaced by "a material very subtle, very viscous, and very ready to dry and harden." "They" (certain "elementary spirits") coat with this material a piece of linen, and present it to the objects which they wish to paint," &c.

In the two last examples the pictures formed reproduce the images of the objects, with their natural colours and their forms, so that the objects are seen as if reflected in a mirror. The photographs of the present day are still very far from this ideal perfection, which, however, they will probably never cease to approach without ever being able to reach.

Rotterdam J. A. GROSHANS

[1] Paris, Auguste Desrez 1837, tome 2me, p 643.

[2] Le Vieux Neuf, Histoire Ancienne des Inventions et Découvertes Modernes Paris, Dentu, 1859

[3] Giphantie, à Babylone, MDCCLX., 12°.

Average Annual Temperature at Earth's Surface

HAVING lived for many years both in the southern and northern hemispheres, I have a very strong impression that if means were taken to ascertain, with more or less approximation, the average annual temperature at the earth's surface, by a combination of the daily averages of a sufficient number of places of observation, there would be found a very considerable difference in the yearly values of the said average annual temperatures. But whether, on inquiry, there should prove to be a decided difference or an absolute agreement between these averages, the fact in either case would surely be worth ascertaining, and could not fail to be instructive. It might be objected that it would be impossible to obtain the observations of the daily average temperature from such a number of observatories as would render the desired annual average for the whole earth of any value, but I think this objection overstates the difficulty. Suppose that the subject were taken up by some one of the meteorological authorities in Great Britain, it would not be difficult to obtain from existing daily records, a good average annual value for the temperature of the British Islands. Similarly, an average annual value could be obtained for the temperature, from the daily averages in the various colonies and dependencies of the British empire; and I take it to be certain, that the conductors of the various meteorological observatories all over the empire would cheerfully respond to an invitation to co-operate in such a work. In a similar scientific spirit it is to be hoped that the observatories of all civilised countries would be willing to exchange their observations, and an approximate result could thus be arrived at, possibly in two or three years. Certainly, it might be at first a rough approximation only, but it would be yearly becoming better with the rapid increase of meteorological observatories all over the world. And as it is not too much to hope that, sooner or later, the whole habitable earth will be civilised and covered with observatories, it is certain that the figures ultimately obtained to represent the average annual temperatures at the earth's surface would have the value of scientific approximations of considerable accuracy. If this be so, it cannot be too early to begin these statistics now.

Supposing that these annual averages should exhibit a difference in their yearly values, it is probable that these differences would vary in sympathy with the total sun-spot areas of the years to which they belonged. What could be done for temperature, could be done at the same time for other subjects of meteorological investigation, and it is impossible to anticipate at present what light these tabulated annual averages might be able to throw upon various problems of solar and terrestrial physics.

Balham, December 4 D. TRAILL

ON A MEANS FOR CONVERTING THE HEAT-MOTION POSSESSED BY MATTER AT NORMAL TEMPERATURE INTO WORK

IN a previous article[1] we considered how, by a simple mechanical means, diffusion renders it possible to derive work from matter at normal temperature. As the subject is an important one we propose to develop it somewhat further here.

2. The normal temperature of objects on the earth's surface represents a vast store of energy in the form of molecular motion. The sea (for example) at normal temperature possesses an amount of molecular energy which (by computation), if it were entirely utilised, would be competent to lift it to a height of upwards of seventy miles. The air and the crust of the earth itself possess comparable amounts of energy. It might therefore well be asked beforehand whether it is not possible to transfer some of this intense molecular motion to masses and utilise it. It may be observed that this intense store of energy is being continually dissipated in space in the form of waves (by radiation). The energy possessed by the molecules of matter, however, maintains (as is known) a constant normal value on account of the waves of heat received from the sun, whose mechanical value at the earth's surface (as represented by the results of Herschel and Pouillet) is normally equal to about one-horse power per square yard of surface. Here, therefore, we have a continual store of motion kept up in the molecules of matter on the earth's surface to be wasted in great part in imparting motion to the ether of space. It would certainly look, *à priori*, as if there ought to be some means of utilising this store of motion.

3. The second law of thermodynamics would (as is known) assume that this would not be practicable. This law was propounded simply as what was considered a legitimate inference from the observed behaviour of heat. But a great advance in the knowledge of the nature of heat has been made since that time, and it should be noticed that the law is (admittedly) by no means *theoretically* necessary or requisite to satisfy the principle of the conservation of energy. Indeed a conceivable case opposed to it has been pointed out by Prof. Maxwell, though one not capable of being practically carried out. It was my purpose in the last article to direct attention to a physical process opposed to the law and admitting of practical realisation, in the effects attendant on the diffusion of matter. At the time when this law was enunciated the character of the motion termed "heat" (as illustrated in the now accepted kinetic theory of gases) was unrecognised, and therefore the *mechanism* of the diffusion of gases was not understood. Under these conditions, therefore, it would not be much a point for surprise if increase of knowledge should show the law not to be generally applicable (or not to admit of that general application which is implied by the use of the term "*law*").

4. It may serve greatly to facilitate the following of this subject if we visualise the relations of heat and work more closely. Since "*heat*" is simply a *motion* of small portions of matter (termed "molecules"), and since the

[1] "On the Diffusion of Matter in Relation to the Second Law of Thermodynamics," see NATURE, vol. xvii. p. 31.

transference of this motion to visible masses is called "*work*," so therefore the conversion of heat into work is no more than the transference of motion from small to large portions of matter, *i e.*, the transference of motion between portions of matter of *different* dimensions. *The mechanical equivalent of heat* therefore simply represents *the equivalence in energy between the motions of portions of matter of different dimensions* (molecules and visible masses). To deny, therefore, that the heat possessed by matter at normal temperature could be converted into work would be to assume that by a certain difference in dimensions the conditions are such that motion can no longer be transferred from the smaller portions of matter to the larger. This would evidently, *à priori*, be by no means a necessary assumption; indeed it would appear, perhaps, rather strange that by no device could such a thing be done.

5. At the first sight one difficulty in the way of utilising this motion that surrounds us on all sides is that the larger scale portions of matter (visible masses) are immersed among the smaller scale portions of matter (molecules) which surround the visible masses on all sides (as the molecules of the surrounding air, &c.), so that a perfect equilibrium of motion exists on all sides; so that it becomes impossible to transfer the motion to the larger scale mass in the one direction or in the other, and we cannot lay hold of each moving molecule individually, on account of its minute size.

6. It is an observed fact (and demonstrated theoretically) that portions of matter in motion among themselves tend to acquire the *same* energy of motion (called "temperature" in the case of molecules). In accordance with well-known facts, whenever the energy of this system of small moving portions of matter is greater in one part than in another, *i.e.*, whenever the equilibrium of energy is upset, then we can transfer some of the energy to larger scale masses (convert heat into work). Is there, however, no other means of converting heat into work but through *inequality of energy?* It was pointed out in the last article that *inequality of velocity* (by the mechanism of diffusion) will serve the same purpose. The portions of matter (molecules) which by equal temperature possess equal energy, possess, when their *masses* are unequal, unequal velocities. This inequality of *velocity* can be utilised for work as well as inequality of *energy*.

7. Since size is only *relative*, or there is nothing absolute in size, it will be quite legitimate to suppose molecules magnified up to a larger scale so as to be visible, and we do this as in dealing with the *mechanism* of a process, it is almost impossible to visualise or conceive clearly the results without this condition, and it is our object, on account of its practical bearing, to exhibit the process involved in a clear light. Suppose, therefore, the molecules of two diverse gases (oxygen and hydrogen) to be magnified up to visible dimensions, and as we are not concerned with the shape or form of the molecules, we may simply represent the molecules of the two gases by a number of spheres, those representing hydrogen possessing each one-sixteenth of the mass of those representing oxygen, and also possessing a normal velocity four times as great. This is known to be the fact in the case of the two gases when at the same temperature. We will further suppose the spheres inclosed in the two separate halves of a cylinder with a piston between them. The spheres may either be supposed perfectly elastic or their motion kept up artificially in some way; just as in the case of a gas the motion of its molecules is kept up by the molecular vibrations of the sides of the cylinder.

8. The spheres of the two sets possess *equal* energies of motion, the one set making up in mass for what they want in velocity. The colliding spheres in each compartment will arrange themselves (according to a known principle) so that the number of spheres in unit of volume of each set is the same, and therefore the pressure exerted by their impacts on opposite sides of the piston will produce perfect equilibrium, so that the piston remains immovable. Now the question is, supposing that (as in the case of molecules) we cannot lay hold of each of these spheres separately, is there any means of utilising the *inequality* of velocity for the performance of work? [This is the question we have to make in the case of two gases at the same temperature, whose molecules we cannot grasp, and which possess *unequal* velocities.] If we could by any device get a number of the spheres from one compartment into the other without changing their velocities in the act, then the pressure would evidently rise in one compartment, and we should thus obtain a capacity for work without the performance of work. It is evident that this could be done by making several perforations in the piston, about the size of the spheres themselves, so that the spheres, in impinging against the piston would sometimes happen to encounter the void space of a hole, and thus pass through with unchanged velocity into the opposite compartment. If the spheres of the two sets were moving with *equal* velocities, it is evident that as many on an average would pass through one way as the other, and there would therefore be no disturbance of the equilibrium of pressure, and consequently no work to be derived. But from the fact that the spheres are moving with *unequal* velocities, a different result will ensue. It will be evident that the number of spheres passing through the hole will be proportional to the number of times they strike against the piston, for the chances that a sphere will encounter a hole will be proportional to the number of its impacts against the piston, *i.e.* to the *velocity* of the sphere. So the velocity of the spheres in one compartment being four times that in the other, four times as many lighter spheres pass through one way, as heavier spheres pass through the other. The number of spheres in one compartment will therefore rapidly augment, and thus the *pressure* against the piston will rise, and the piston will be finally driven towards the opposite end of the cylinder, and in this act *energy* will be transferred from the spheres in the one compartment to those in the other; or part of the energy could be transferred to an outside mechanism in a self-acting manner if desired, by simply connecting the piston to the mechanism.

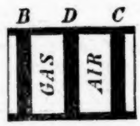
9. Now if precisely the same thing can be done in the case of two gases, it is evident that here the energy being *heat*, we have in the result attendant on the motion of the piston, the transference of heat from one portion of gas to another at normal temperature, *i.e.* the transference of heat in a self-acting manner from a *colder to a hotter portion of matter*; and if desired, a conversion of a part of the heat of the gas (at normal temperature) into *work* by cooling it down below the temperature of the coldest of surrounding objects.

10. In the case of a gas it is clear that we cannot make perforations analogous to the above sufficiently small to suit molecules, but to attack molecules we must have recourse to *molecular* mechanism, or to attempt to handle them like the spheres we must have recourse to mechanism on a suitable scale. We have such a mechanism in a porous diaphragm (such as of pipeclay or plumbago) which represents a piston with *molecular* perforations. Such a diaphragm, if fitted as a piston into a cylinder will exhibit, with the molecules of two separate gases possessing different molecular velocities (such as molecules of oxygen and hydrogen), precisely the same phenomena as those exhibited, simply on a magnified scale in the case of the spheres; or the above description applies word for word. We have by the motion of the porous piston *the conversion of the heat-motion of the gas at normal temperature into work*, the transference of heat automatically from the *colder* portion of gas to the warmer. The second law of thermodynamics only holds when the molecules brought into contact happen to be of the *same*

kind, or, more accurately speaking, of the *same mass*. This latter case is evidently exceptional, and if a case be exceptional the term "*law*" becomes no longer applicable to it.

11. The rates of diffusion of hydrogen and oxygen across the porous diaphragm are known to be as four to one, *i.e.* as the *molecular velocities*. The above illustration of the spheres may serve to exhibit the *physical basis* or cause of this fact in a clear light. The mere statement that the rates of diffusion are inversely as the square roots of the molecular weights of the gases, evidently throws no light on the cause or *physical basis* of the action, which is always the main thing to realise in physical science. The fact that diffusion is in the above ratio to the molecular weight, evidently only happens to be true because the molecular *velocity* is in that same ratio to the molecular weight, otherwise molecular weight has nothing whatever to do with the rate of diffusion. So it will be equally apparent, from the above illustration, that the rate of diffusion of a gas through a porous diaphragm has nothing whatever to do with the *pressure* of the gas, but depends, *cæteris paribus*, on the number of molecules of the gas in unit volume. An increase of the number of molecules in unit volume (by adding to the number of impacts of the molecules against the vessel) increases the pressure, and this is why diffusion *appears* to be dependent on pressure, though evidently *physically* it has nothing to do with it. This serves to explain how, provided the molecular velocities of the gases are considerably diverse, such enormous differences of pressure can take place by diffusion through a porous diaphragm, the pressure having no power whatever to adjust itself through the diaphragm; for the passage of a molecule through the diaphragm simply depends whether, in its normal motion, it happens to encounter a pore or not. The above illustration may also serve to show that the velocity of propagation of any impulse ("wave") by a system of bodies in free collision can only be dependent on the *normal velocity of the bodies*, just as a system of couriers interchanging motion among themselves convey a message at their own rate. So the molecules of a gas interchanging motion among themselves convey an impulse at their own rate, and thus the velocity of sound in a gas can be solely dependent on, and proportional to, *the velocity of the molecules of the gas*, and on nothing else. This must evidently be true on the basis of the kinetic theory, and this theory being now accepted, it would be not unreasonable to expect that in so fundamental a matter as the propagation of sound, an explanation of it on the basis of this theory would be looked to, for a *statical* theory of the propagation of sound appears scarcely to harmonise with the *dynamical* theory of gases. We have alluded to this fact as briefly as possible, having the illustration of the spheres at hand. There may be a liability to lose sight of facts like the above unless due care be taken to realise molecular phenomena by picturing them on a larger scale. The velocity of sound in hydrogen is four times greater than in oxygen, solely because the velocity of the molecules of hydrogen is four times greater than the velocity of the molecules of oxygen—nothing conceivably to do with the molecular weight of the gas, excepting in so far as a less molecular weight determines a higher molecular *velocity*.[1] The rate of propagation of the wave is affected by temperature in so far as the *velocity* of the molecules of the gas (in whose motion the *heat* of the gas consists) is affected by temperature.

12. As an illustration of a simple form of apparatus adapted for converting normal temperature heat into work, and admitting of continuous actuation, the following rough sketch may serve:—Let the annexed diagram represent a cylinder containing three pistons, B, D, C, the



central one, D, of which is furnished with any porous diaphragm (such as of plumbago, or porous earthenware). Let any light gas (hydrogen being the most effective) be supposed introduced into one-half of the cylinder, some heavier gas (or air) filling the other half. All three pistons are supposed (first) fixed. Then, as is known, diffusion commences through the porous diaphragm, everything remaining necessarily at normal temperature so long as the pistons are fixed and no work is done. The rapidly moving molecules of the light gas pass in greater numbers through the pores of the diaphragm than those of the heavy gas (or air), so that the pressure rises in the compartment originally filled with air. As soon as the pressure has attained a maximum, the central piston is automatically released, and is thus driven by the excess of pressure towards the opposite end of the cylinder, the portion of gas which does the work being chilled and the heat transferred in the form of work to the outside machinery with which the central piston is connected. A certain part of the heat goes to the portion of gas *towards* which the piston is driven, heat thus passing from a colder to a hotter body (for as soon as the portion of gas commences to be chilled, it is already the colder). Simultaneously with the stroke of the central piston, a convenient automatic arrangement connected with the machinery oscillates the two end pistons inwards and outwards, expelling in the inward stroke (through convenient openings) the diffused mixture of gas and air, and by the outward stroke drawing in a fresh supply. Of course the valves suitable for this are not given, as it is only our purpose to sketch the *principle* of such an apparatus as a scientific point, and having no regard to any question of commercial value or not. Clearly the power derived would depend on the specific gravity of the gas used, and would be proportional (*cæteris paribus*) to the area of the piston. Coal gas would give a less power than hydrogen. A diffused mixture of gas and air is necessary for gas engines, the mixture being exploded in them. It is clear that it would be possible, by means of an apparatus of the above character, to derive power in the act of mixing the gas and air previous to exploding the mixture. The gaseous mixture, after passing through the apparatus, could be stored in some reservoir or receptacle, so as to recover (before combustion in the gas engine) from surrounding objects the heat which it lost by conversion into work in the diffusion engine. By this procedure it may be observed that the heat converted into work is derived from *the normal store of heat possessed by surrounding objects*, and their store is finally made good by the sun, which latter may therefore be regarded as the ultimate source of the energy derived.

13. In view of the numerous porous structures existing in the animal and vegetable world (*porosity* being a distinguishing characteristic of animal and vegetable organisms), also taking into consideration the prevalence of gases of different molecular weights, notably oxygen and carbonic acid (which are known to be intimately connected with animal and vegetable processes); the conclusion would seem warranted, and even necessary, that work on the above principle must take place widely in nature, and thus part of the store of energy accumulated in materials on the earth's surface by the sun, is made to fulfil a useful end, instead of being dissipated uselessly in space.

S. TOLVER PRESTON

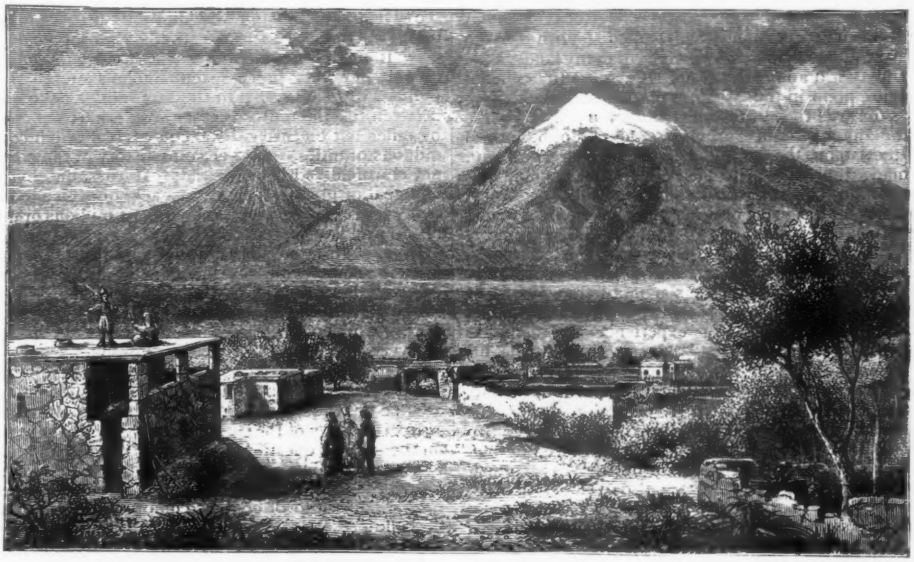
[1] It is evident that though the velocity of the wave is proportional to the velocity of the molecules, the *absolute* velocity of the wave must be to a certain fixed degree less than that of the molecules; for the molecules in their normal motions are moving more or less *obliquely* to the path of the wave. This I have pointed out in a paper, published in the *Philosophical Magazine* for June, 1877, where the true mathematical relation for the velocity has been determined by Prof. Maxwell, and is there given.

ARARAT[1]

IN the childhood of mankind the dwellers in Western Asia cherished the story of a great flood which drowned all their race save one man and his family. They told the tale from father to son, how the flood rose till it covered their highest hills, and how the ark in which their ancestor had saved himself, his family, and a motley crowd of animals floated on the waters until, when these abated, it came to rest on the first emerging summit of the land. They chose as the scene of this new starting-point for humanity the loftiest peak of which they had knowledge—a vast snowy cone shooting far into the blue air above, and shrouding itself every day in cloud and storm. No one had ever climbed to its mysterious summit since the ark rested there. But generation after generation looked up to it with awe and veneration from the plains of Armenia. The story spread far away into other lands. It became part of the religious teaching of nearly a half of mankind. No mountain is so familiar, all the world over, as that from which Noah is famed to have descended to re-people the earth. The first conception which, as children, most of us have formed of a mountain, arose out of this story of Ararat.

Apart from its legendary associations and the mystery arising from its reputed inaccessibility, there must be something strangely fascinating about Ararat. Men who have seen much of mountains in many countries speak of it as the noblest mass among them all. The summit of its snowy cone (17,000 feet) greatly exceeds any European peak in elevation, and sweeps up from the level plain of the Araxes (2,500 feet) as from a sheet of water. It looks as if it might well claim to be linked with the oldest of human traditions.

So impressive a mountain, so long associated with man's faith and history, would have been appropriately placed among the most ancient landscapes of the earth's surface. Some scenes suggest only the changes of yesterday; others set us thinking of the earliest condition of our world. We naturally look for a kind of consonance between the venerable antiquity of the associations which gather round Ararat and the primeval character of the



Great and Lesser Ararat from the North-east.

mountain itself. But geology delights in contrasts, and nowhere could so impressive a contrast be found between the remoteness of the tradition and the comparative youth of the mountain on which it lingers. Here we find no colossal pyramid of granite with outer folds of more ancient rocks such as have been built up and carved into the oldest mountain-chains. In reality it is but a mountain of yesterday, possibly not so old as the advent of man upon the earth, certainly much younger than many plants and animals now living.

To a student of the evolution of the earth's surface-features there is something profoundly suggestive in the long line of depressions and ridges which separates Europe from Africa, and stretches eastward through the heart of Asia. On the one hand, he sees the basins of the Mediterranean, Black, Dead, Caspian, and Aral Seas; on the other he notes how, in a general sense, parallel with these deep troughs, run massive mountain ridges, including the great axis of the Old World. He finds, on closer research, that while most of these ridges have received their latest upheavals at a recent geological date, they yet for the greater part belong originally to earlier periods of disturbance, some of them, indeed, bearing witness to many successive uplifts during a vast section of geological time. Yet further examination will bring before him evidence that along some of these lines of earth-folding, volcanic action has of old been abundant; and that the present Mediterranean volcanoes are but the lingering remnants of the chain of actively burning mountains which ran through Asia Minor and crowned the peaks of the Caucasus. And he will discover that just as there have been successive uplifts of the same axis or mountain-chain, so have there been widely-separated outbursts of volcanic activity during a long course of ages from the same focus of discharge.

It is in relation to this remarkable history that Mount Ararat acquires its main geological interest. Thanks chiefly to the veteran Abich a good deal is now known of the geology of the Caucasian and Transcaucasian ridges. He has shown how a nucleus of Devonian and car-

[1] Transcaucasia and Ararat. By James Bryce. (London: Macmillan and Co., 1877.)

boniferous limestone rocks appears even under the mass of Ararat, and has drawn the inference from his wanderings in that region, that in the beginning of the Upper Carboniferous Limestone period a great continental upheaval took place during which the Armenian region received its first outlines. The land thus raised he believes to have remained above water until, in the course of the Cretaceous period, it so far sank as to become an island, and continued in this condition even into Pliocene times, when the whole of that region became involved in another vast continental upheaval to which the final modelling of the Armenian highlands was due. These great terrestrial movements were accompanied by the outbreak of volcanic action. Abich regards the diabase, diorite, and porphyry rocks as having been abundantly erupted during the Jurassic period and to have played an important part in the formation of the mountain masses, especially in the Lower Caucasus. To late Tertiary times, however, belong the trachytic and doleritic lavas which have been poured forth on so colossal a scale as to form such mountains as Elbruz, Kasbek, Ala Göz, and the two Ararats.

In Mr. Bryce's recently published volume (to which attention has already been drawn in NATURE) we have a record of the latest and probably the most daring ascent of Mount Ararat. Though not a professed geologist he has had a geological training, and has seen much of many lands, alike in the Old World and in the New. It was not to make out any obscure point in the structure of Ararat that he bent his steps towards that little known mountain. But he had climbed many a peak in Europe, and he no doubt longed to set foot upon the high places of another continent. So he made a pilgrimage to the heights of Armenia, with no thought, however, of writing a book about his journey. The volume he has just published has been partly wrung from him by the importunity of friends, who reasonably supposed that the world might be as much interested as they in knowing more about Ararat. In its charmingly fresh and graphic pages one gets such a living picture of the mountain as cannot be gained from any of the geological memoirs. From long experience of mountain climbing his eyes are so keen and so trained, while his pen is so facile and vivid that we can mount with him as he goes warily over each lava-current, rubbish-cone, and snow-slope. We feel the sharp thin air of the mountain as it blows through his narrative. We join in his quiet chuckle as he halts at a solitary piece of wood far up on the cone and irreverently detaches a fragment for the inspection of those who cannot personally discover whether the true ark still rests on the top of Ararat. And we can sympathise with his awe as he stood among the clouds alone on the summit of the mysterious mountain. It is not for any new scientific facts so much as for the vivid sketch of the general aspect of the huge volcanic mass that his book has an interest to geologists.

A vignette of Ararat forms the frontispiece of the volume, which is here reproduced. In the middle distance is shown the alluvial plain of the Araxes. Below the snowy cone and icy cliffs of the Greater Ararat a deep cleft or recess appears with huge cliffs somewhat like the Val del Bove of Etna, and no doubt due to some of the volcanic explosions of the mountain. On the skyline of this slope, towards the base of the larger cone, some of the late cinder-cones and craters appear. Some of these are still so fresh and perfect that they look as if they had been active only the other day and might blaze forth again to-morrow. The graceful outline of the Lesser Ararat rises on the left. ARCH. GEIKIE

AGE OF THE SUN IN RELATION TO EVOLUTION

ONE of the most formidable objections to the theory of evolution is the enormous length of time which it demands. On this point Prof. Haeckel, one of the highest authorities on the subject, in his "History of Creation," has the following :—"Darwin's theory, as well that of Lyell, renders the assumption of immense periods absolutely necessary. . . . If the theory of development be true at all there must certainly have elapsed immense periods, utterly inconceivable to us, during which the gradual historical development of the animal and vegetable proceeded by the slow transformation of species . . . the periods during which species originated by gradual transmutation, must not be calculated by single centuries, but by hundreds and by millions of centuries. Every process of development is the more intelligible the longer it is assumed to last."

There are few evolutionists, I presume, who will dispute the accuracy of these statements; but the question arises, does physical science permit the assumption of such enormous periods? We shall now consider the way in which Prof. Haeckel endeavours to answer this question and to meet the objections urged against the enormous lapse of time assumed for evolution.

"I beg leave to remark," he says, "that we have not a single rational ground for conceiving the time requisite to be limited in any way. . . . It is absolutely impossible to see what can in any way limit us in assuming long periods of time. . . . From a strictly philosophical point of view it makes no difference whether we hypothetically assume for this process ten millions or ten thousand millions of years. . . . In the same way as the distances between the different planetary systems are not calculated by miles but by Sirius-distances, each of which comprises millions of miles, so the organic history of the earth must not be calculated by thousands of years, but by palæontological or geological periods, each of which comprises many thousands of years, and perhaps millions or milliards of thousands of years."

Statements more utterly opposed to the present state of modern science on this subject could hardly well be made. Not only have physicists fixed a limit to the extent of time available to the evolutionist, but they have fixed it within very narrow boundaries.

Every one will admit that the organic history of our globe must have been limited by the age of the sun's heat. The extent of time that the evolutionist is allowed to assume depends, therefore, on the answer to the question, What is the age of the sun's heat? And this again depends on the ulterior question, From what source has he derived his energy? The sun is losing heat at the enormous rate of 7,000 horse-power on every square foot of surface. And were it composed of coal its combustion would not maintain the present rate of radiation for 5,000 years. Combustion, therefore, cannot be the origin of the heat.

Gravitation is now almost universally appealed to as the only conceivable source from which the sun could have obtained his energy. The contraction theory advocated by Helmholtz is the one generally accepted, but the total amount of work performed by gravitation in the condensation of the sun from a nebulous mass to its present size could only have afforded twenty million years' heat at the present rate of radiation. On the assumption that the sun's density increases towards the centre, a few additional million years' heat might be obtained. But on every conceivable supposition gravitation could not have afforded more than twenty or thirty million years' heat.

Prof. Haeckel may make any assumption he chooses about the age of the sun, but he must not do so in regard to the age of the sun's heat. One who believes it *inconceivable* that matter can either be created or annihilated may be allowed to maintain that the sun existed from all eternity, but he cannot be permitted to assume that our luminary has been losing heat from all eternity.

If 20,000,000 or 30,000,000 years do not suffice for the evolution theory, then either that or the gravitation theory of the origin of the sun's heat will have to be abandoned.

In a former paper (*Quarterly Journal of Science* for

July, 18,7) I have proved from geological evidence that the antiquity of our habitable globe must be at least three times greater than it could possibly be had the sun derived its heat simply from the condensation of its mass. This proves that the gravitation theory of the origin of the sun's heat is as irreconcilable with geological facts as it is, according to Haeckel, with those of evolution, and that there must have been some other source, in addition, at least, to gravity, from which the sun derived his store of energy.

That other source is not so inconceivable as has been assumed, for it is quite conceivable that the nebulous mass from which the sun was formed by condensation might have been possessed of an original store of heat previous to condensation. And this excessive temperature may be the reason why the mass existed in a nebulous or rarefied condition. Now if the mass were originally in a heated condition then in condensing it would have to part not merely with the heat of condensation, but also with the heat it originally possessed.

The question then arises—By what means could the nebulous mass have become incandescent? From what source could the heat have been obtained? The dynamical theory of heat affords, as was shown several years ago (*Phil. Mag.* for May, 1868), an easy answer to this question. The answer is that the energy in the form of heat possessed by the mass may have been derived from *motion in space*. Two bodies, each one-half the mass of the sun, moving directly towards each other with a velocity of 476 miles per second, would, by their concussion, generate in a *single moment* 50,000,000 years' heat. For two bodies of that mass, moving with a velocity of 476 miles per second, would possess $4{,}149 \times 10^{38}$ foot-pounds of kinetic energy, and this, converted into heat by the stoppage of their motion, would give out an amount of heat which would cover the present rate of the sun's radiation for a period of 50,000,000 years.

There is nothing very extraordinary in the velocity which we have found would be required to generate the 50,000,000 years' heat in the case of the two supposed bodies. A comet having an orbit extending to the path of the planet Neptune, approaching so near the sun as to almost graze his surface in passing, would have a velocity of about 390 miles per second, which is within eighty-six miles of that required.

It must be borne in mind, however, that the 476 miles per second is the velocity at the moment of collision. But more than one-half of this velocity, or 274 miles per second, would be derived from their mutual attraction as they approached each other. We have consequently to assume an original or projected velocity of only 202 miles per second. If the original velocity was 678 per second, this, with the 274 derived from gravity, would generate an amount of heat which would suffice for 200,000,000 years. And if we assume the original velocity to have been 1,700 miles per second, an amount of heat would be generated in a single moment which would suffice for no less than 800,000,000 years.

It will be asked, Where did the two bodies get their motion? It may as well, however, be asked, Where did they get their existence? It is just as easy to conceive that they always existed in motion as that they always existed at rest. In fact, this is the only way in which energy could remain in a body without dissipation into space. Under other forms a certain amount of it is constantly being transformed into heat which never can be retransformed back again, but is dissipated into space as radiant heat. But a body moving in void stellar space will retain its energy in the form of motion undiminished and untransformed for ever, unless a collision takes place.

The theory that the sun's heat was originally derived from motion in space is, therefore, for this reason, also more in harmony with evolution than the gravitation theory, because it explains how the enormous amount of energy which is being dissipated into stellar space may have existed in the matter composing the sun untransformed during bygone ages. Or in fact for as far back as the matter itself existed.

In conclusion there are only two sources conceivable from which the sun could have derived his heat. The one is *gravitation*, the other *motion in space*. The former could have afforded only about 20,000,000 or 30,000,000 years' heat, but there is in reality no absolute limit to the amount which may have been derived from the latter source, for the amount generated would depend on the velocity of motion. And when we take into consideration the magnitude of the stellar universe, the difference between a motion of 202 miles per second, and one of 1,700 miles to a great extent disappears, and the one velocity becomes about as probable as the other.

It may be urged as an objection to the theory that we have no experience of bodies moving in space with such enormous velocities as the above. This objection, for the following reason, is of no weight.

No body moving with a velocity exceeding 400 miles per second could remain a member of our solar system; and beyond our system there is nothing visible but the stars and nebulæ. These stars, however, are suns like our own, and visible because, like the sun, they have lost their motion—the lost motion being the origin of their light and heat. Bodies moving in stellar space with these enormous velocities can have neither light nor heat, and, of course, must be invisible to us. They must first lose their motion before the kinetic energy in the form of motion can be transformed into light and heat, so as to constitute visible suns.

JAMES CROLL

ON THE FORMATION OF HAILSTONES, RAINDROPS, AND SNOWFLAKES[1]

THE author commences by recapitulating some of the leading points in a paper which he read before the same Society on October 31, 1876, "On the Manner in which Raindrops and Hailstones are Formed." In this paper, which was published in NATURE (vol. xvi. p. 163), he had shown that the aggregation of the small cloud particles into raindrops or hailstones is sufficiently accounted for by the fact that the larger particles descend faster than the others, and consequently overtake those immediately beneath them, and, combining with these, form still larger particles, which move with greater velocity, and more quickly overtaking the particles in front of them, add to their size at an increasing rate. He also showed that the shape and structure of ordinary hailstones was exactly such as would result from this manner of formation. For he had observed that the shape of hailstones was not as it at first sight appeared, that of more or less imperfect spheres, but that of more or less imperfect cones or pyramids with rounded bases, the conical surfaces being striated, the striæ radiating from the vertex; the texture being that of an aggregation of a number of small ice particles without crystalline form, being packed more closely together toward the base or rounded face of the stone. In this paper the author had reverted to the possibility of making *artificial hailstones* by blowing a stream of frozen fog against a small object, making, as it were, the cloud to rise up and meet the stone, instead of the stone falling through the cloud.

He had not, however, then overcome the difficulty of obtaining such a stream of frozen fog, but gave two sketches of plaster stones, which, as far as their shape and the striated appearance of their surface were concerned, closely resembled hailstones, and which plaster stones had been obtained by blowing some finely-divided

[1] Abstract of paper by Prof. Osborne Reynolds, F.R.S., read at the Manchester Literary and Philosophical Society.

plaster of Paris against small splinters of wood by means of a jet of steam.

In the discussion which followed the reading of that paper Dr. Crompton suggested the ether spray, such as is used in surgery, as a means of obtaining a frozen fog, and Prof. Reynolds explains how after various attempts he had succeeded in combining a spray of ether and water so as to form artificial stones. He then proceeds as follows:—

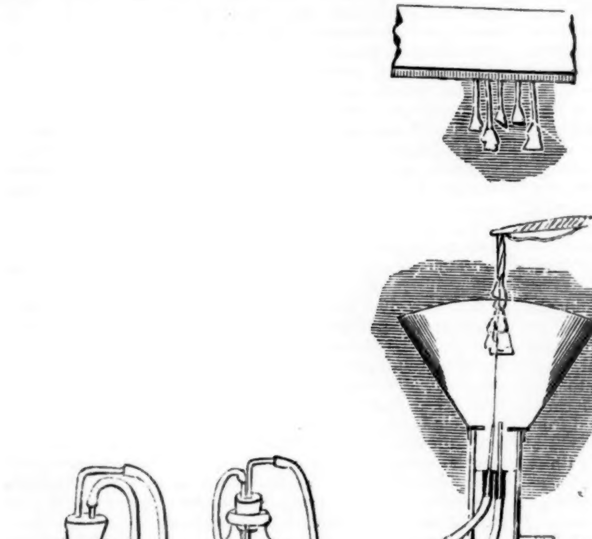


FIG. 1.

The apparatus is shown in Fig. 1. It consists of a brass tube half an inch in diameter, one end of which is connected with bellows capable of maintaining a constant pressure of about 18 inches of water, on the other end of the tube is a cap over the end of which is a flat plate or diaphragm having a central opening $\frac{1}{8}$ of an inch in diameter which forms the aperture for the blast. Entering through the sides of the main brass tube are two small brass tubes which reach to within $\frac{1}{2}$ an inch of the plate and into the ends of which are sealed fine glass capillary tubes, the glass being very thin; these protrude just through the middle of the aperture, the one about $\frac{1}{16}$ of an inch and the other $\frac{1}{32}$. Through these tubes the water and ether are separately introduced into the blast to form the spray, and it is mainly on the adjustment of these tubes that the efficiency of the apparatus depends. It is essential that the ether tube should be slightly the longest, otherwise the ends become stopped with ice, and I find it better that the ether tube should be somewhat larger than the water tube. The bore of the tubes must be very small, but this is not sufficient, for unless the glass is very thin the spray will not be finely divided. Both the ether and water are forced through the tubes from bottles by connecting the interiors of these bottles with the bellows, and the quantities of ether and water are regulated either by raising and lowering the bottles or by means of the cocks in the pipes.

The tube is fixed in an ordinary retort-stand, so that the blast is vertical. If then a small splinter of wood is held pointing downwards into the spray, a lump of ice forms on the end of the splinter, and this lump has all the appearance of the hail-stones. It is quite white and opaque, it is conical in form and has a rounded base and striated surface.

In this way I have formed stones from half to three-quarters of an inch in diameter. When, however, the stones are growing large it is necessary to move this splinter so as to expose in succession all parts of the face of the stone to the more direct action of the spray.

When using this apparatus in a warm room I have found it best to fix a pad of blotting paper over the jet at a height of 10 or 12 inches. The surface of this pad is cooled by the spray and prevents radiation from the ceiling, which otherwise tends to melt the top of the stone. For a similar reason I have found it well to surround the blast with a wide cylinder or inverted cone of paper, which keeps off radiation without interfering with the action of the jet.

By sticking several pieces of wood into the pad, pointing downwards, a number of stones may be made at once.

In Fig. 2 a medium-sized stone as well as one of the largest stones are shown attached to the splinters of wood. The surface of the cone, where continuous, is truly conical, or rather pyramidal, but this surface is broken, as it were by steps, and a very marked fact is that all the continuous surfaces have the same vertex, and hence the different conical surfaces to which they belong, have not the same vertical angle, the surface being exactly such as would be acquired by the fragments of a sphere so constituted that the fracture tended to follow radial lines.

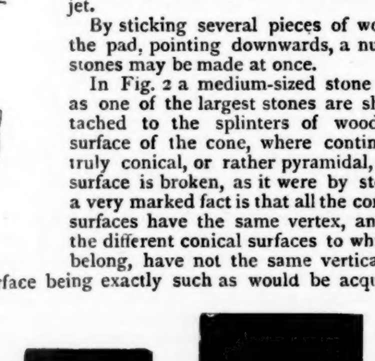


FIG. 2.

Owing to the radiation of the surfaces from a common vertex and the steps which occur between the vertex and the base, the angle of the conical surface of the stone is greater near the vertex than near the base. Thus the smaller stones appear less elongated than those which are larger.

The fact that in the sketches of actual stones, which I gave in my last paper, I showed the steps as less pronounced and the angles larger than they are in the artificial stones, is probably owing in some measure to my having formed my ideas from the observation of favourable specimens chosen from amongst those which fell. The larger angles were probably also, in part, owing to the smaller size of the actual hailstones, which were not much more than one-fourth of an inch across. But I think that it is important to notice that the somewhat imperfect way in which the outside layers in the surface of the artificial stones are continued, may be owing to the narrowness of the jet of air which, on striking the stone, tends to diverge laterally rather than to flow upwards past the sides of the stone, as it would do if the jet were broader, or as the air must do when the stone is falling through it.

The rate at which stones can be formed depends on the amount of water which can be introduced into the spray, the larger stones taking from one to two minutes. At first sight this may seem to be somewhat slow, but the following estimate tends to show that the artificial are probably formed quicker than the actual stones.

The speed of the jet of air at the point at which the stones are formed is nearly equal to that at which the larger stones would fall through the air. This is shown by the fact that if a large stone becomes accidentally detached from its splinter of wood it rather falls than rises, but when this happens with smaller stones they are driven up by the force of the blast.

I find that the speed of the blast varies from 150 to 200 feet per second, *i.e.*, from one-and-a-half to two miles a minute. The larger stones, therefore, traverse from one to four miles of frozen spray. So that if we imagine a cloud as dense as the spray it would have to be from one to four miles thick in order that the stones might, in falling through it, attain the size of the artificial stones; and considering that the stones would only gradually acquire a speed equal to that of the blast, the time occupied in falling through the cloud would in all probability be very considerable, at least from five to ten minutes after the stone had acquired a sensible size.

As regards the proportion which the density of spray bears to that of a cloud, a comparison may be made from the fact that when working in saturated air at a temperature of 60° or 70° F., the condensation of vapour supplied sufficient ice to form the spray; and since it is probable that the dense summer clouds, from which hail is formed, result from the cooling of air from temperatures nearly, if not quite, equal to this, there is probably no great difference in the density of the clouds and the spray.

I have not yet had an opportunity of examining the texture of these stones under the microscope, but to all appearance they consist of an aggregation of small spherical particles of ice; and it seems worthy of notice that while nothing like a snow crystal ever appears to be produced in the ether spray, the moment the blast is stopped the end of the ether tube becomes covered with ice, which often assumes the form of snow crystals.

This appears to indicate the character of the difference between those conditions which result in snow and those which result in hail.

When the cloud particles are formed at or above the temperature of 32° and then freeze, owing to cooling by expansion or otherwise, the particles as they freeze retain their spherical form. This is what happens in the spray.

On the other hand, when saturated air at a temperature below 32° is still further cooled, the deposition of the vapour will be upon ice, and will take the form of snow crystals.

The aggregation of the snow crystals into flakes is, as I pointed out in my previous paper, accounted for by the larger crystals overtaking the smaller crystals in their descent, and the still more rapid descent of the flakes as they increase in size.

As regards the formation of rain-drops, I have nothing to add to what was contained in my last paper. The same explanation obviously applies to both hail and rain, and any doubt which may have been left by the less direct arguments in my former paper will, I venture to think, have been removed by the verification of my predictions in the production of artificial hailstones so closely resembling in all particulars those formed by nature. And, in conclusion, I would thank Dr. Crompton for the suggestion of the means by which I have been able to produce these stones.

OUR ASTRONOMICAL COLUMN

THE SOUTH POLAR SPOT OF MARS.—Prof. Asaph Hall has instituted a series of measures of the position of the south polar spot of Mars, with the Washington refractor during the late favourable opposition of the planet, having been led thereto by the great discordances in the positions of the spot, as determined so far. He adopts Oudeman's node and inclination of the equator of Mars, which, for the epoch taken, viz., 1877, September, 17·0, G.M.T. give $N = 47° 56'$, $I = 39° 14'$, and the angle of position of the south pole 162° 6', and assumes the time of rotation of the planet 24h. 37m. 22·73s., as found by Mr. Proctor. The observations were made with a power of 400, and on thirty-two nights, from August 10 to October 24, during the whole of which period the spot was always seen with great distinctness, and little change in its appearance noted except what might be accounted for by change of distance. From thirty-four equations of condition treated on the method of least squares, Prof. Hall finds for the angle of position of the south pole of Mars at the above-mentioned epoch 166° 22', for the radius of the small circle described by the spot 5° 11', and for the angle of position of the spot at the epoch, with respect to the rotation-axis of the planet, 311° 24'. The various determinations of the south polar distance of this spot are as follow:—

	°	′		°	′
Herschel, 1783 ...	8	8	Linsser, 1862	20	0
Bessel, 1830	8	6	Kaiser, 1862	4	16
Mädler, 1837	12	0	Hall, 1877	5	11
Secchi, 1857	17	42			

On several of the finer nights, when the markings on the edge of the spot were very distinct, it appeared as "a depression in the surface of the planet."

PROF. NEWCOMB'S LUNAR RESEARCHES.—It is understood that if no unforeseen delay occurs in the printing, Part I. of "Researches on the Motion of the Moon," upon which Prof. Newcomb has been engaged for six years past, will be ready for publication in the course of next month. It is devoted to the discussion of eclipses and occultations previous to 1750. An abstract appeared in *Silliman's Journal* for November last.

THE CORDOBA OBSERVATORY.—In an address delivered on November 4, on the occasion of receiving from the Governor of the province of Cordoba the premiums awarded at the Centennial Exhibition in Philadelphia to the Argentine National Observatory and to himself for Lunar and Stellar Photographs, Dr. B. A. Gould gave a brief outline of the successive applications of photography to astronomical purposes since Mr. Bond's experiments with the 15-inch refractor of Harvard Observatory in 1850, with more particular reference to work executed at Cordoba of late in this direction. Dr. Gould expresses

himself satisfied with the results obtained at the Argentine Observatory; the photographs of the moon at full and in the last quarter he thinks may be favourably compared with any obtained elsewhere which he had seen. He refers to "the very beautiful picture of the moon" made with the 4-feet reflector at Melbourne, which was also exhibited at Philadelphia," and adds, he is not sure, if he had seen this elegant photograph before placing his own on exhibition he would have ventured to compete. Dr. Gould remarks that much of the credit of the stellar photographs is due to the pure air of Cordoba, which is incredibly transparent on the not very numerous occasions when the sky is really clear. The impressions on glass exhibited were of six different clusters, the plate of the cluster X Carinæ containing two images each of 185 stars, and that of η Argus containing 180, and many of the stars as faint as the ninth magnitude. Measurable photographs of not less than eighty-four celestial objects have been secured, of which nineteen are double stars and the remainder clusters. The planets Jupiter, Mars, and Saturn, have also been photographed "with sufficient distinctness to show clearly the details of light and colour on the surfaces of the two former, and the existence of the ring in the latter," but the images have not been sufficiently sharp to allow of successful photographic enlargement.

VARIABLE STARS.—Herr Palisa in *Ast. Nach.*, No. 2,174, mentions his having remarked a new variable star, the position of which for 1877·0 is in R.A. 16h. 4m. 35s., N.P.D. 109° 48'·9. It does not occur on Chacornac's chart No. 49; it was 10m. on May 26, 1876, and on July 31 and August 3 of last year, whereas on May 17, 1877, no trace of it was perceptible. The period is therefore no doubt comparatively short.

The star L. 36606 = B.A.C. 6641 appears to vary from 6·5m. to 9m. On October 17, 1852, Argelander estimated it of the former magnitude, Lalande and Piazzi call it an eighth, while about midsummer, 1851, it was little, if anything, over the ninth magnitude.

L. 26211 is probably variable from 6m. to 8m., and L. 27307 from 7m. to 9m., and it is not unlikely that further observations will place δ^2 Geminorum on the list of variables; it has been rated at a fifth magnitude and as low as $8\frac{1}{2}$.

THE MINOR PLANET EVA.—A planet of the eleventh magnitude, observed by Herr Palisa at Pola on December 29, is mentioned in the *Bulletin International* of January 3, as possibly No. 180, but according to a communication from Herr Knorre, of Berlin, as probably identical with No. 164, detected by M. Paul Henry at Paris on July 12, 1876, which received the name *Eva*. The observations of 1876 extended over an interval of little more than a fortnight, and the elements which have been calculated by Mr. Winslow Upton and M. Bossert are therefore liable to uncertainty, but if we adopt Mr. Upton's orbit and compute for the time of the Pola observation, the place is found to be about a degree only from that observed, and it is therefore probable that No. 180 has yet to be discovered.

THOMAS VERNON WOLLASTON

THE very limited band of scientific English entomologists has just suffered a great loss by the sudden death, on the 4th instant, at his residence, 1, Barnepark Terrace, Teignmouth, of Thomas Vernon Wollaston—a name dear to science, and of which he well upheld the reputation. Accurate, elaborate, and precise *ad punctum*, and naturally of a minutely critical habit, he nevertheless persistently acted upon a broad conception of the science to which he was devoted; and taking advantage of the periodical banishments to a warmer climate imposed upon him in early manhood by pulmonary weakness, set himself the task of thoroughly investigating the coleopterous fauna of the Madeiras, Salvages, and Cape de Verdes, and finally of St. Helena. His philosophical deductions from the vast mass of well-sifted evidence obtained (chiefly by his own bodily toil, though he was always in a more or less debilitated state of health) referring to these isolated groups, may be summed up as corroborating the former existence of that submerged Atlantis whereon geologists differ. From the exhaustive care with which his material was obtained, it seems highly unlikely that his premises were insufficient; and his discussion of the subject so far resembles Mr. Darwin's method that it supplies the objections likely to be raised, and itself practically exhausts criticism by minuteness of observation.

To students of British entomology, Mr. Wollaston is best known by his early papers in the *Zoologist* and Stainton's *Entomologists' Annual and Weekly Intelligencer*, and by his revision of *Atomaria* in *Trans. Ent. Soc.*, 1877. His first scientific contribution was in the *Zoologist*, vol. i. (1843), on *Coleoptera* at Launceston, when a student at Jesus College, Cambridge (where, with the late J. F. Dawson and Hamlet Clark, he imbibed from Dr. Babington a taste for natural science), and his last, a paper in the *Annals and Magazine of Natural History*, on a weevil destructive to the banana in Madeira, was received from him by the writer almost simultaneously with the news of his death. He published many descriptive and analytical papers, almost exclusively on *Coleoptera*, in the above-named publications, the *Journal of Entomology* and the *Entomologists' Monthly Magazine*; but his *magnum opus* is the well-known "Insecta Maderensia," published in 1854, the results of his sojourns in Madeira, to which he first went in 1847. This, from its amount of novelty and classical treatment, at once established his reputation.

His collection, increased by another visit in 1855, having been purchased by the trustees of the British Museum, he prepared a more complete account, which was published as a museum "Catalogue" in 1857. Subsequent visits in 1858 and 1859 resulted in a description of the coleopterous fauna of the Canaries, also published as a museum "Catalogue" in 1864. The acquisition of fresh material compelled him in the next year to write his "Coleoptera Atlantidum," an arduous critical work of nearly 700 pages, followed in 1867 by the "Coleoptera Hesperidum," a valuable descriptive account of the species of the Cape Verde Archipelago, visited in 1866. His last contribution to geographical entomology, "Coleoptera Sanctæ-Helenæ," 1877, contains a multiplicity of unexpected developments (especially after the supposed exhaustion of the productions of the island in Mr. Melliss's work), and shows that St. Helena is the home of a special family, *Cossonidæ*, to which Mr. Wollaston had always devoted attention, having himself described no less than 255 new species in it, as against 67 described by all other naturalists, living or dead.

Of his other works, it may suffice to mention one on the "Variation of Species," published in 1856, and another, "Testacea Atlantica," that will, alas, be posthumous (though complete), being a descriptive account of the land-shells of his favourite hunting-ground.

The amount of work in these publications and in others not referred to, is astonishing, especially to those who know the extreme precision (both in manipulation and writing) and the weak physical condition of the author. Mr. Wollaston became a Fellow of the Linnean Society in 1847, and was also a Fellow of the Cambridge Philosophical Society, but, beyond his university degree, sought no other honorary distinction. He was, we believe, in his fifty-seventh year at the time of his death. E. C. R.

NOTES

WE may remind our readers that on this day, a century ago, one of the great reformers of science—perhaps the most celebrated naturalist of all times—Linné, breathed his last. His

name is too familiar to our readers to necessitate any biographical remarks on our part. His countrymen will doubtless commemorate the day in a fitting manner, and the sanctum at Upsala University, Linné's room, which is still preserved in its original state, will, we are sure, be visited by many a scientific pilgrim.

AT the last general meeting of the Royal Academy of Sciences of Brussels, the five years' prize for natural sciences was awarded to Prof. van Beneder, of Liége, the son of the celebrated zoologist of Louvain.

THE Emperor of Austria has recently awarded the large gold medal "for art and science" to the well-known African traveller, Dr. Oscar Lenz.

THE African traveller, Herr Gerhard Rohlfs, is now organising an expedition for the investigation of the eastern part of the Great Sahara. He will be accompanied by a number of scientific men, amongst others by Prof. Zittel, of Munich. Tripoli will be the head-quarters of the expedition, and its first efforts will be the exploration of the mysterious oases, Wajanga and Kufara, in the south of Anjila, which have never been visited by any European travellers.

AT Frankfort-on-the-Main a new society has been formed with the sole object of watching over the interests of chemical industry.

AMONGST the students of Strassburg University the idea has ripened to erect a monument in memory of Goethe as the most eminent representative of German culture, and as the ideal of a German student. The monument is to stand in front of the new University Building, and is to represent the poet as he appeared at the time of his sojourn at Strassburg, in the prime of youth and strength, and in the costume of that period. Most of the professors of the University regard the idea favourably, and the inhabitants of the city are confidently expected to do the same.

ANOTHER Pompeii has been accidentally discovered in the neighbourhood of Mount Gargano, near Manfredonia. There were found an ancient temple of Diana, a magnificent portico about twenty metres long, with an underground necropolis of great extent. A large number of important inscriptions has already been forwarded to, and exhibited by, the National Museum of Naples. The discovered city is the ancient Sipuntum, near Arpinum, mentioned by Strabo and Titus Livius. The houses are nearly twenty feet beneath the cultivated soil. This town was at the time ingulfed in consequence of a terrible earthquake. The Italian Government has ordered researches to be made on a large scale.

WE are glad to learn that a telegram received at Rome from Cairo announces that the Marquess Antinori had arrived at Zeyla, from which he intended to start at once for Italy. It is not known, however, as yet whether he is alone or accompanied by other members of his expedition.

MR. STANLEY has left Alexandria for England by Brindisi. He is expected to visit Rome, Marseilles, and Paris, on his way home, and speak on his work to the geographical societies of these cities. The Khedive invested Mr. Stanley with the order of the Grand Cross of the Medjidie, accompanied by another order of the next grade, thus conferring upon Mr. Stanley the title of Grand Officer of the Order of the Medjidie.

M. GAUTHIER VILLARS has published the new issue of the *Annuaire* of the Bureau des Longitudes of France, which contains a large number of geographical data. It is the first time that such a quantity of interesting numerical data has been collected in this small volume. In addition the volume contains two essays, one by Dr. Janssen on Solar Photography, and the other on Cosmical Meteorology by M. Faye. The latter denies any connection to exist between either solar spots, magnetic disturbances, or the motions of Jupiter, and the positions of the moon and variations of weather.

THE death is announced of General La Marmora, who always took a lively interest in the progress of science in Italy, and often gave his substantial aid to the establishment of practical scientific schools.

SIGNOR MENGONI, one of the greatest architects of Italy, builder of the well-known Vittorio-Emanuele Gallery at Milan, has fallen from the great arch of that building, whilst giving directions for the completion of this his life-work; he died instantly.

MESSRS. MACMILLAN have in preparation the first part of a "Course of Instruction in Zootomy," by Prof. Huxley, assisted by Mr. T. J. Parker. This part will consist of directions for the dissection of readily-obtainable examples selected from each of the classes of the vertebrata, accompanied by full descriptions of the parts displayed.

WE notice the appearance of a very interesting Russian work by M. Nemirovich-Danchenko, entitled "The Land of Cold," being a description of the author's travels in the White Sea to the coast of Russian Laponia, to Kandalaksk Bay, Novaya Zemlya, and Waigatz Island. The work has no pretensions to be scientific, but it is full of interesting and useful information on the inhabitants of the regions visited. The able descriptions are chiefly devoted to the life of the walrus- and seal-hunters, but it contains, besides lively pictures of such life, abundant statistical data as to the state of those industries, and descriptions of the varied manners in which they are carried on in different parts of Northern Russia. An important part of the work is devoted to descriptions of Samoyedes, Korels, Zyrians, Yuraks, Chukchees, Kamchadalians, Lapps, and Ural Cossacks, based on the author's own notes and other recent information. The work, extending to 520 pages, is illustrated with twenty-five full-page illustrations, and is written in the attractive style characteristic of the author, who is well known in Russia.

THE anniversary meeting of the Vienna Geographical Society was held on December 18. The Society now numbers seventy honorary, 132 corresponding, and 641 ordinary members. The Austrian Minister for Public Instruction has granted a yearly subsidy of 1,000 florins to the Society for the period of three years, and this sum, as well as other donations it has received, have enabled the council to enlarge the Society's library, which during the past year was increased by 234 new works and nineteen geographical views, as well as to facilitate materially the publication of scientific works, and to support geographical exploration. The receipts of the Society during 1877 were 7,332 florins, the expenses 7,110 florins. The President, in his report, announced that the scientific investigations made in Central Africa by Dr. Oscar Lenz and Lieut. Lux, will soon be published, and that the Austrian traveller, Dr. Emil Hollub, after a sojourn of nearly three years in South Africa, will shortly return to Austria.

PHYLLOXERA, that pernicious enemy of the vine, which hitherto had mainly restricted its devastations to the wine-growing districts of France and Switzerland, seems lately to be gaining ground in Germany as well. It is announced that it has appeared in a vineyard at Rauschwitz, near Glogau, as well as in a viticultural establishment at Plantières, near Metz. In the former case the vines had been purchased last spring from one of the numerous horticulturists of Erfurt. The necessary measures are being taken to prevent the spreading of the plague. In France phylloxera seems also on the increase; at Saint Medard and other places of the Gers Department the vines are covered by such masses of the insect that the latter can easily be seen by the naked eye, which is generally not an easy matter.

A NEW weekly serial for horticulturists has been published since January 1 at Berlin under the title *Der deutsche Garten.*

THE contract made between Alsace, Baden, and Switzerland, for the protection of the fisheries in the Rhine and its tributaries, has recently come into force. The states mentioned agree to issue similar laws with regard to fisheries, and to further, in every possible way, the maintenance and increase of the valuable species of fish both in the Rhine and in the Lake of Constance. The contract has been signed for the space of ten years, and the participation of the other Rhenish states is much desired.

IN the last session of the Deutsche Gesellschaft für öffentliche Gesundheitspflege, Dr. Falk described a new method of testing the purity of drinking water by electrical experiment. From researches carried out in the laboratory of the School of Artillery in Berlin, it appears that the conductive properties of water for the electric current vary rapidly according to its degree of purity, the resistance decreasing with the purity of the water. It is possible, in this manner, to detect with great ease the presence of small quantities of organic matter in water.

IN the last session of the Naturforschende Gesellschaft of Görlitz the President, Dr. Peck, made an interesting communication on a newly-discovered enemy of the carp. It appears that large numbers of the spawn of this fish are attacked by the Water-bug (*Ranatra linearis*), which fastens itself firmly on the back of its prey with its forefeet, and by means of its sharply-pointed trunk, sucks out the small amount of blood in the young organism. A series of experiments conducted in some large establishments for fish culture show that the only method of fighting this new foe is to drain the ponds dry and restock them with fish.

A CONSIGNMENT of soles and turbot was sent from the Southport Aquarium on Thursday last to America in charge of Mr. Mather, agent to Prof. Baird, United States Commissioner of Fish and Fisheries. If they arrive safely they are destined to be turned adrift in the Bay of Massachusetts. It appears that while so many members of the *Pleuronectidæ* are common enough on the American coast, soles and turbot are entirely unknown. Hence a journey to England was arranged by Prof. Baird to see if these desirable fish could not be safely transmitted across the Atlantic.

THE members of the Scientific Club will learn with regret that Mr. Logan Lobley, F.G.S., has tendered his resignation of the office of secretary to the Committee of the Club.

WE regret to record the death, on December 22, of Mr. James Whatman Bosanquet, F.R.A.S., M.R.A.S., &c., who was distinguished by his researches in biblical chronology and Assyrian history. He helped forward in many ways the investigations by Mr. George Smith, by Boscawen, and others, which have resulted in the recent famous discoveries. His valuable suggestions with reference to certain solar eclipses as bearing on the subject have frequently been acknowledged by the Astronomer-Royal and by Mr. Hind.

THE death of M. François Vincent Raspail, one of the deputies for Marseilles, is announced. The deceased deputy, who was born in 1794, achieved scientific distinction early in life, and for many years past has held a high reputation on account of his chemical researches. Notwithstanding these scientific pursuits, M. Raspail throughout his life took an ardent and active part in political affairs.

Vanity Fair is informed that the Khedive has granted to a Dutch Company the right of draining Lake Mareotis, and utilising the land reclaimed. Its area is about 75,000 acres, and the company has bound itself to hand over to the Viceroy a certain proportion of the crops raised.

WE have received the first number of the *Revue Internationale des Sciences*, which we recently announced as about to appear. There are two original papers, one by M. Balbiani, on "The Importance and Rôle of Embryogeny," and the other by Prof. von Nägeli, on "The Lower Fungi and the Decompositions which they determine." The rest of the number is mainly occupied with reports of societies.

THE *Gardener's Chronicle* learns with much pleasure that Mr. Bentham has finished the "Flora Australiensis," and that the seventh and last volume of this useful work will shortly appear. The first volume was published in 1863, so that the work has proceeded at the rate of one volume every two years. Not a very rapid rate, it is true; but still it compares favourably with the pace of other publications of the same kind. Mr. Bentham has had the advantage of Baron von Mueller's co-operation in this great work.

A DANISH agricultural journal recommends to those of its readers who wish to provide themselves every winter with a sufficient supply of ice to last during the whole of the summer the following simple means of increasing the thickness of ice during mild winters:—Long and intense cold is necessary to produce a coating of ice of more than two or three inches' thickness upon a surface of water of any considerable extent. But if a hole is made in the ice and the surface from time to time covered with a shallow layer of water, even moderately cold weather will suffice to freeze this water, and by repeating the experiment ice of ten inches or a foot in thickness is obtained without much difficulty. The Danish journal therefore proposes the use of portable pumps to be placed into the ice-holes for the purpose described.

THE apparatus used by M. Cailletet for the liquefaction of the gases was constructed by M. Ducretet, the philosophical instrument maker, and was put into operation in the laboratory of the Paris Normal School during last week, where it has been visited by a number of scientific men.

TWO shocks of earthquake were felt at Beachburg, Renfrew co., Ontario, on the morning of December 18 last, the first being between the hours of one and two, the last between five and six o'clock. The latter was so severe as to shake the houses and arouse the inmates from their beds. Beachburg is situated in the same district in the Ottawa Valley in which the earthquake of November 4 was felt most severely.

THOSE who have visited that charming watering-place, Tenby, in South Wales, will know how exceptionally rich the locality is in fossils, sea-shells, and especially in bone caves, some of which contained human remains and stone implements. Mr. Smith of Gumfreston, who has just died, is celebrated for the researches he made in the limestone caves and barrows of the neighbourhood, and his collection of bones, implements, urns, &c., is most extensive and interesting, and, on the authority of Prof. Rolleston, one of the most complete ever got together by a single individual. Through the liberality of Mr. Chas. Allen and others, the whole of the money for the purchase of this collection is forthcoming, but only on condition that a suitable building shall be provided to hold it. At its last meeting the British Association made a money grant for the further examination of the Tenby bone caves, so that it is of the utmost importance to science that a good local museum should be established to prevent these most valuable specimens being scattered all over the country. Those of our readers who really wish practically to help in promoting the cause of local museums have now an opportunity of doing so by forwarding subscriptions to Charles Allen, Esq., 10, Norton Tenby, South Wales. At the same time the people of Tenby and of Pembrokeshire generally will surely have public spirit enough and a sufficiently clear perception of their own interest not to let this fine collection slip through their hands.

MR. DENIS D. REDMOND writes from Dublin in reference to Dr. Röntgen's telephone alarum, calling attention to one which he has found very effectual. He simply sends the current of an ordinary magneto-electric machine through the instrument, which produces a loud hum that is distinctly heard many yards away.

THE last number of the *Isvestia* of the Russian Geographical Society contains three letters from M. Potanin from Khobdo and Ulassutai, which, though written in January, March, and July, reached the society only in October. The winter in Khobdo was very cold; the thermometer stood in January as low as $-27°$ Cels. at noon, and even $-37°$ at seven o'clock in the morning; but the western gales brought a much warmer temperature, those of October 15, November 24, and December 24, having been the heaviest, and the last causing a rise of temperature from $-19°{\cdot}8$ to $-0°{\cdot}4$ Cels. There was little snow, so that the birds could easily find their food, and M. Potanin has noticed no less than fifty species (the insectivorous *Podoces hendersonii* was among them), which wintered at Khobdo. In March M. Potanin started for Hami. He crossed the eastern part of the Altai Mountains, the Altain Nuru, and soon reached the Gobi Steppe, which takes two days to cross, one night having to be passed without food for the horses and without water. On the southern frontier of the Steppe he was at the Chinese town Santaru. Thence he crossed the Mechin-ola Chain, which runs parallel to the Tian-Shan, and entered the Barkul depression. Hami was reached on May 23, and the travellers, who were kindly received by the authorities, stayed for some time. They returned thence to Ulassutai, *i.e.*, after having crossed the chain mentioned above, turned east, following a series of Sart's settlements at the northern foot of the eastern part of Tian Shan, or Karlyk-Tagh, covered with perpetual snow. At Nom-Tologoy settlement they turned north, crossed for a second time the Gobi Steppe, and afterwards the Altai ridge, and reached Ulassutai on July 25. A survey was made throughout the route, and collections of birds and plants, especially alpine, were obtained. From Ulassutai M. Potanin intended to visit the almost unknown tracts at the sources of the Yenissei, Lake Kosogol, and thence to return by way of Lake Ubsa-nor to Biysk.

THE *Allgemeine schweizerische Gesellschaft für die Gesammten Naturwissenschaften*, of Zurich, has just published the second part of its volume for 1877, which contains but one, but a very elaborate treatise, on the spiders of Switzerland. The paper occupies no less than 320 quarto pages, and is accompanied by six well-drawn plates. The author is Prof. Hermann Lebert, and his work is a most valuable addition to zoological science.

A NEW ethnographical museum is about to be erected in Paris, and is to contain everything that is of any value in relation to the science of ethnography.

THE new volume of the *Popular Science Review* commences well. The January number has several good articles, that on "The Old and the New Chemistry" being specially interesting.

IN reference to our note last week on the specimens in the Westminster Aquarium, it is the specimen of *Menobranchus lateralis* which is said to be the first shown in England.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. F. Wood; a Striped Hyæna (*Hyæna striata*) from Arabia, presented by Capt. F. Cotton; a Red and Yellow Maccaw (*Ara chloroptera*) from Cartagena, presented by Capt. King; a Naked-eared Deer (*Cervus gymnopis*) from Venezuela, presented by Mr. Cyril Graham; a Robben Island Snake (*Coronella phocarum*) from South Africa, presented by Messrs. Rice and Jamrach; a Macaque Monkey (*Macacus cynomolgus*) from India, deposited.

AMERICAN SCIENCE

IN the December number of the *American Journal of Science and Art*, Mr. Holden collates various observations, by the Herschels and others, on the trifid nebula M 20, discovered by Messier, June 5, 1764, who, however, gives no details concerning it. The result of the inquiry is to show (1) that from 1784, when Sir William Herschel first described it somewhat in detail, to 1833, the remarkable triple star observed in the nebula, was centrally situated between the three nebulosities; (2) from 1839 to 1877 the triple star was not centrally situated, but involved in one of the nebulosities (A). The idea that the triple star has a large proper motion being thought improbable, it is concluded that the nebula has undergone marked changes of position, or brilliancy, or both, during the period 1784 to 1877. The conjecture was thrown out by Sir John Herschel, that "perhaps this singular object has a proper motion."

In a recent survey of the Connecticut Valley, one of the most interesting features is the discovery of a massive gravel ridge, often nearly covered by the alluvium of the highest terraces extending from Lyme, N. H., to Windsor, Vt. (twenty-four miles). It occupies nearly the middle of the valley, and resembles the gravel ridges that have been known under the various names of *kames*, in Scotland, eskers in Ireland, and asar in Sweden. The theory of the origin of the kames, commonly accepted, is that they were heaped up through the agency of marine currents, during a submergence of the land. It seemed impossible to account thus for the kames in the Connecticut and Merrimack valleys (one is found in the latter also), which, being bordered on both sides by high hills, would have been long estuaries open to the sea only at their mouths, and therefore not affected by oceanic currents. The date of their formation is known to be between the period when the ice-sheet moved over the land, and that closely following, in which the more recent and modified drift was deposited in the open valley from the floods that were supplied by the melting ice; and Mr. Warren Upham, who describes these kames, is thus led to attribute their formation to the action of the glacial rivers, which flowed in channels on the surface of the ice-sheet; the kames having been formed at or near their mouths, extending along their valleys, as fast as the ice front retreated.

Among many important discoveries made last summer by the United States Fish Commission are those of two new species of fishes, named respectively *Macrurus bairdii* and *Lycodes verrillii*. Particulars of these and of a number of other unusual forms are communicated by Messrs. Goode and Bean.

The Museum of Yale College has recently received the greater portion of the skeleton of a huge reptile which proves to be one of the most remarkable animals yet discovered. It was found by Prof. Lakes and Engineer Beckwith in upper Jurassic beds in Colorado on the eastern flank of the Rocky Mountains. The present species (*Stegosaurus armatus*) was probably thirty feet long, and moved mainly by swimming. Some of the teeth preserved have compressed crowns and are inserted in sockets (one is 112 mm. long, greatest diameter of crown, 24 mm.), others are cylindrical and are placed in rows, either in thin plates of imperfect bone or in cartillage (the latter may prove to be dermal spines). The body was protected by large bony dermal plates (one of these was over three feet in length).

Prof. Marsh also contributes a notice of some new Dinosaurian reptiles from the Jurassic formation.

The employment of chromic acid in various volumetric determinations is recommended by Mr. Hinman, who gives examples of his mode of procedure.

We learn from the *New York Tribune* that the last earthquake in the West was supposed to have radiated from a locality in Nebraska that has been popularly regarded as the site of a volcano. Prof. Samuel Aughey, of the Nebraska State University, has recently made an examination of the ground. The seat of disturbance is on the banks of the Missouri, in Dixon County, about thirty-six miles from Sioux City. A bluff, about 1,100 feet long and 160 feet high, sloping at an angle of 60° to 80° toward the river, is at present the place where the phenomena are most exhibited, but other bluffs at a few miles' distance have been similarly affected. On the bluff sounds were heard proceeding from the interior, especially on placing the ear to the ground. Flames sometimes broke forth, occasionally at night. Steam escaped from crevices. On digging into the bluff, intense heat stopped the work after proceeding a few feet. Selenite, alum, and magnesic sulphate in crystals were abundant. Prof. Aughey regards these features as not volcanic in the usual sense

of the term, but simply the result of local chemical action. The formation is cretaceous. The bluff is capped by calcic carbonate. Beneath are shales containing ferric bisulphide in crystals of pyrites. Below the shale is a soft limestone, containing carbonates of magnesia and alumina. The chemical reactions consequent upon part of the soil being soaked with water after its fall toward the river, have been the decomposition of the pyrites, the production of sulphuric acid, and the attack of the acid on the alkaline carbonates. The heat evolved in the first of these reactions is, of course, very great; in the latter part the violence must be increased by the liberation of carbonic anhydride. All the authenticated disturbances are thus easily explained. Prof. Aughey does not connect them with the earthquake.

Prof. J. L. Campbell, of Washington and Lee University, has been collating and discussing the data for the great meteor which was seen in many parts of Virginia on the afternoon of November 20. He concludes that its height was about 100 miles; but this estimate is merely approximate. Its course seems to have been 8° or 10° west of north. Its explosion appears to have taken place over the south-east corner of Halifax County, about fifteen or twenty miles a little south of west from Clarksville, 100 miles from Richmond, eighty from Lexington, and fifty-five from Raleigh. It was a meteor of unusual size and brilliancy, and detonated loudly when it exploded.

The corner-stone of a building for the accommodation of the Davenport Academy of Natural Sciences was laid on October 4, and is almost the first edifice west of Chicago intended for purely scientific purposes; the building is expected to be ready for occupation this month. The Academy is a young institution, which has grown very rapidly, and has already assumed a prominent position among establishments of this kind in the United States. This is due principally to the excellent character of its *Transactions*, filled with interesting information, and especially rich in subjects relating to American archæology. Part 1 of vol. ii. has been sent us.

If the descriptions are not overdrawn, a remarkably convenient small steam engine has been invented in Philadelphia. It is an oscillating engine, attached to a tank holding about two gallons of water. The boiler is of about a quart capacity; the steam-chest half that size; the whole concern occupies a space of about 10 inches square and 18 high, and weighs 35 pounds. It is designed for use with any sort of light machinery, and is said to be suitable for a variety of domestic work. The details of the contrivance are not yet stated, but assurances are given that it cannot, under any circumstances, explode; that it is as manageable as an ordinary gas burner, since the inventor has succeeded in dispensing with water and steam gauges and automatic floats, so that the whole apparatus is simple, and no skill is required to operate it. The kitchen of the future is expected to contain one of these engines, to chop hash, turn the coffee-mill and the roasting-jack, sift ashes, and mangle the family linen.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

EDINBURGH.—The matriculation returns for the past year have now been completed, and show a considerable increase in the number of students in residence over any former period. The numbers on the register for 1876 were 2,302, for 1877 they amount to 2,56[illegible]. The students are divided between the several faculties as follows:—In the faculty of arts, 953 students; of theology, 67; of law, 364; and of medicine, 1,176. The ground is now being cleared for the erection of the University Extension Buildings, which, with the aid of the Government grant, will be vigorously proceeded with, and thus furnish the additional accommodation so urgently required for the increasing number of students, and for the fuller development of the teaching resources of the University.

TAUNTON COLLEGE SCHOOL.—A first-class microscope by Smith and Beck, a handsome clock and centre-piece, a purse containing 136*l.*, and addresses emblazoned on parchment, from the old boys, the parents, and the friends of the school, have been presented to the Rev. W. Tuckwell, on his leaving Taunton.

FRANCE.—M. Bardoux will propose to the French Parliament, during its present session, to organise, in each department (there are eighty-nine), a high primary school after the model of the École Turgot, one of the municipal schools of Paris. He will also introduce a bill for enlarging the Sorbonne, the traditional head-quarters of the University.

BERLIN.—The professorship of botany, which has been vacant since the death of Alexander Braun last March, is now to be filled by Prof. Eichler, of Kiel, who has accepted a call to this position as well as to the directorship of the Botanical Gardens in Berlin. He enters upon his duties next April. During the *interim* the gardens are under the direction of Prof. Koch.

GÖTTINGEN.—The present attendance at the University is 909, a slight decrease on the past summers. They are divided among the faculties as follows: theology, 86; medicine, 115; law, 275; philosophy, 433. The representation of foreign countries is unusually small, with the exception of America, which supplies a contingent of 27. The corps of instructors, numbering 116, includes 9 in theology, 26 in medicine, 14 in law, and 67 in philosophy and science.

ERLANGEN.—The University is attended at present by 448 students, a slight increase on the number of the past summer. Bavaria contributes 305, the remaining 143 coming from the other parts of Germany and from abroad. Medicine includes 110, pharmacy 56, chemistry and the natural sciences 32, mathematics and physics 10.

SCIENTIFIC SERIALS

THE current number of the *Quarterly Journal of Microscopic Science* commences with Dr. Roberts' address at the Manchester meeting of the British Medical Association on the doctrine of Contagium Vivum and its application to medicine.—Following this is Part 4 of Mr. Archer's *résumé* of recent contributions to our knowledge of "Fresh-water Rhizopoda," including the Rhizopoda, Monothalamia, Monostomata.—Prof. Carl Vogt's account of *Loxosoma* is abstracted, with notes, by Rev. T. Hinks. The genus is confirmed as a Polyzoon, and allied to *Pedicellina*. Its ova and reproductive buds are described, as well as the different organs, in detail.—A paper by Prof. Arthur Boettcher treats of the results arrived at by treating red blood corpuscles with alcoholic solution of corrosive sublimate.—Dr. Klein contributes a paper on the minute anatomy of the epidermis in small-pox of sheep.—The last paper is Prof. Lankester's important notes on the embryology and classification of the animal kingdom; comprising a revision of speculations relative to the origin and significance of the germ-layers. This paper has since been separately published.

Annalen der Physik und Chemie, No. 10.—On the border angle and the expansion of liquids on solid bodies, by M. Quincke.—On the specific heat of vapours and their variations with the temperature, by M. Wiedemann.—Determination of the ratio of the specific heats for air at constant pressure and constant volume by the velocity of sound, by M. Kaiser.—On the internal friction of solid bodies (continued), by M. Schmidt.—On the doctrine of aggregate states, by M. Ritter.—Manometric method of determining the specific gravity of gases, by M. Reeknagel.—On the disaggregation of tin, by the Editor.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, Dec. 13, 1877.—"Experimental Researches on the Electric Discharge with the Chloride of Silver Battery," by Warren De la Rue, M.A., D.C.L., F.R.S., and Hugo W. Müller, Ph.D., F.R.S. Part I.

The paper in question deals mainly with the striking distance between terminals of different forms in air and in other gases at ordinary atmospheric pressures; and in air at reduced pressures short of the partial vacua of the so-called vacuum tubes.

The authors have found that the discharge of the battery, with one or two poles in the form of a point, presents several interesting phenomena which precede the true jump of the spark, and which do not occur with other forms of terminals; for example, discs or spherical surfaces. With 8,040 cells the striking distance between a paraboloidal point, positive, and a disc is about 0·34 in. (8·64 millims.), but there is always a luminous discharge. Very apparent, far beyond the distance measurable by their micronometer-discharger, namely, 1·16 inch (29·5 millims.), as they have before stated.[1]

The current which passes during the luminous discharge which

[1] *Proc. Roy. Soc.*, 1876, vol. xxiv. p. 169.

precedes the jump of the true spark is extremely feeble, in comparison with that which takes place after the spark has passed and the voltaic arc has formed; even when the point and disc are not more distant than ·02 inch beyond the striking distance 0·34 inch for 8,040 elements, it is only $\frac{1}{2864}$th part of it.

The appearance of the discharge is very different, according as the point is positive or negative; it is intermittent in both cases, but is much less discontinuous when the point is negative than when it is positive, as can be seen with a microscope having a rotating minor placed in the bend of the body between the objective and eye-piece. The appearances observed are shown in the wood engravings which illustrate the paper.

Between a point and a disc the spark is longest with the point positive, when from 5,000 to 8,000 cells are used; but for a less number of elements, 1,000 to 3,000, it is longest when the point is negative.

The length of the spark is greatly influenced by the form of the point; thus with a point in the form of a cone of 20 degrees the striking distance is 0·184 inch with 5,640 cells, and 0·267 inches with 8,040, while with a point approaching a paraboloid in form, and with the same base and of the same height as the cone, it is 0·237 inch with 5,640 cells, and 0·343 inch with 8,040.

The striking distance between a point and a plate is in accordance, very nearly with the hypothesis of this distance, increasing in the direct ratio of the square of the number of elements, at all events up to 8,040 cells, thus [1]:—

Number of cells ...	1,000	2,000	3,000	4,000	5,000	6,000	7,000	8,000
	in.	in.	in.	in.	in.	in.	in.	in.
Distance observed ...	0·0051	0·0221	0·0554	0·103	0·159	0·222	0·286	0·352
Distance calculated...	0·0055	0·0220	0·0495	0·088	0·1375	0·198	0·2695	0·352

Between plane, spherical, or cylindrical surfaces, the striking distance does not follow this law; on the contrary, the increase is nearly, but not quite, in the ratio of the number of cells.

	1,000 cells. in.	8,000 cells. in.
Between spherical surfaces	0·0050 ...	0·0810
Plane ,, ,, ...	0·0104 ...	0·0852
Two concentric cylinders	0·0071 ...	0·0991

The striking distance between two paraboloidal points was found to be with—

1,080 cells. in.		8,040 cells. in.
0·005	... ...	0·401

The nature of the metal used for terminals has, in almost all cases, no influence on the length of the spark, but there is one striking exception, namely, in the case of aluminium; when an aluminium point is used the spark is longer than with points of all other metals tried, in the ratio of 1·242 to 1.

The length of the spark is different in various gases; for example, air, oxygen, nitrogen, hydrogen, and carbonic acid, and the ratio between the lengths of spark in various gases varies with the forms of the terminals. The length of the spark bears no simple relation either to the density of the gas or its viscosity.[2]

The paper contains an account of a few experiments on the length of spark in air at different pressures, from 141·5 millims. to 760 millims. Between a point and a disk the length of the spark increases nearly, but not quite, in the ratio of the dilatation; but between two spherical surfaces it increases far more rapidly, and it is possible that at a certain degree of rarefaction the striking distance may be coincident for spherical surfaces and points.

When a strong resistance is interposed in the circuit, 4,000,000 ohms for example, the discharge is completely changed in character; instead of the ordinary spark and production of the voltaic arc, very brilliant snapping sparks pass between the terminals at more or less rapid intervals, exactly like the sparks of a small Leyden jar. Then pierce a piece of writing with minute holes.

It has been found that an accumulated charge of a condenser of 42·8 microfarads capacity, charged with the potential of 3240 cells, produced neither an elongation nor a contraction of a metallic rod 0·2 inch when suddenly discharged through. This charge deflagrates 10·5 inches of platinum wire 0·0125 inch in diameter.

More dense sparks were obtained with one of App's coils for producing 6-inch sparks when the primary was connected with 1080, 2280, 3480 chloride of silver cells, than when it was used with a zinc-carbon, bichromate of potash battery of six cells producing a current 300 times as great, thus showing the influence of high potentials in inducing secondary currents.

These currents of high potentials have also a marked effect in inducing magnetism, when the actual current is taken into account.

The second part of the paper, which is in course of preparation, will deal with the discharge in rarefied gases, in the so-called vacuum tubes.

[1] *Proc. Roy Soc.*, 1876, vol. xxiv. p. 167.
[2] *Proc. Roy. Soc*, vol xxvi. p. 227.

Chemical Society, December 20, 1877.—Dr. Gladstone, president, in the chair.—The following papers were read:—On the constitution of the terpenes and of camphor, by Dr. Armstrong.—Communications from the laboratory of the London Institution, by Dr. Armstrong.—On the hydrocarbons from *Pinus sylvestris*, with remarks on the constitution of the terpenes, by Dr. Tilden. The author has examined the terpenes from Russian turpentine oil and *Oleum foliorum pini sylvestris.* He considers that there are probably only three isomerides amongst the natural terpenes, and suggests a formula for these bodies derived from that of diamylene.—On citric acid as a constituent of imperfectly ripe mulberry juice, by Dr. Wright and Mr. Paterson. This juice was found to contain 26·83 grm. of citric acid and 3·26 grm. of potash salts per litre; the authors point out that it may be valuable as an antiscorbutic, and as a substitute for lime juice.—On cuprous chloride and the absorption of carbonic oxide and hydrochloric acid gas, by J. W. Thomas. The author suggests a ready method of making a solution of cuprous chloride for gas analysis, but finds that although a solution of this salt absorbs carbonic oxide readily, sixty-three per cent. of the gas may be again liberated on neutralising the solution with potash. To avoid such an error he just neutralises the solution of cuprous chloride with ammonia and in this way prepares a solution which introduces into the absorption tube neither free ammonia nor free acid, but which absorbs carbonic oxide with facility. The author has also observed that a saturated solution of ammonic sulphate absorbs hydrochloric acid gas with great readiness, forming an acid salt and ammonic chloride.

Anthropological Institute, December 11, 1877.—Dr. John Evans, D.C.L., F.R.S., president, in the chair.—Dr. James F. N. Wise was elected a member.—Mr. Worthington Smith exhibited some objects from Maiden Bower, and a series of camera lucida drawings of several stone monuments in Wales.—Mr. A. Jukes Browne, F.G.S., exhibited a series of flint flakes, scrapers, and arrow points from Egypt, and read an interesting paper on the subject. He described the geological formation of the country round Helwan about sixteen miles south of Cairo, whence the flints were obtained, and explained the denuding action of the Nile in this locality. He thought that the finding of separate implements in each site pointed to there having been flint manufactories on those spots which, moreover, were near the hot springs. No adzes or celts were found, but fragments of horses' teeth split into long pieces were among the flints. The flints used in the manufacture of these implements were pebbles found on the lower plateau which had been washed down from the hills of eocene limestone above, the upper beds of which abound in siliceous concretions of various sizes.—Mr. Jukes Browne also exhibited some flint implements from a site on the borders of the Fens in Lincolnshire, which appeared to have been a station or manufactory similar to those at Helwan. The president and Mr. Moggeridge made some remarks on the above.—Mr. J. Park Harrison communicated a further report on the "cave-pits" at Cissbury. He said that the galleries belonging to it, and the pits adjoining, appeared to have been used as places of shelter and concealment for some considerable time after they were excavated. No evidence existed at present that they were habitations. One shaft, to which there was access from the cave-pits, was found to have been left unfinished with the horn tools lying where the work had been interrupted. Several small oval pits, the largest only 5 feet long, and 4 feet 6 inches deep, were met with this autumn for the first time in the neighbourhood of the shafts. Among their contents were sling stones and small pieces of flint and fractured rubbing-stone bearing marks of fire, fragments of pottery of various dates, a few flint implements and many flakes; also three weights formed of chalk (similar to some found in Mr. Tindale's pit); a carding-comb, a small iron hook, and three pieces of burnt clay with the impress of sticks on wattles. A few bones of calf, roebuck, pig, and goat, with two or three shells, were the only animal remains. They would appear to have been preserved by the charcoal and charred matter in contact with them. If the little pits were graves

they would appear to have been used for secondary interments, or been otherwise disturbed. The absence of human bones might be due to atmospheric influence, as in many other cases of burial by inhumation. There was black mould at the bottom of all the little pits. Coarse potsherds, flint implements, and burnt pebbles, were also found in the neighbourhood of the small pits near the surface, and may possibly mark the spots where flint-workers of an earlier period were interred. A discussion followed in which several members took part.

Institution of Civil Engineers, December 18, 1877.—Annual General Meeting.—Mr. George Robert Stephenson, president, in the chair.—The numbers of the several classes of members on November 30, 1877, were:—Honorary members, 16; members, 925; associates, 1,670; and students, 448; together, 3,059, as against 2,844 at the same date last year, showing an increase at the rate of about $7\frac{1}{2}$ per cent. The income proper for the year had amounted to 9,903*l.* 5*s.* 3*d.*, the life compositions and admission fees and building fund (all regarded as capital), to 2,113*l.* 13*s.*, and the dividends on trust funds to 462*l.* 16*s.* 6*d.* The general expenditure had reached 10,278*l.* 2*s.*, and the payments on account of trusts were 486*l.* 8*s.* 5*d.* The disbursements were thus 374*l.* 16*s.* 9*d.* in excess of the income. The funded property (including the cash balance) belonging to or under the control of the Institution, was now 38,773*l.* 4*s.* 11*d.*—Mr. John Frederic Bateman, F.R.S., was elected president.

Victoria (Philosophical) Institute, January 7.—Mr. C. Brooke, F.R.S., in the chair.—It was announced that exactly one hundred members had joined during the past year.—A paper on limitations in nature was read by Mr. S. R. Pattison, F.G.S.

Edinburgh

Royal Society, December 17, 1877.—Sir William Thomson, president, in the chair.—Mr. Alexander Buchan read the report of the deputation from the Society to Upsala to assist in celebrating the four hundredth anniversary of the University of Upsala.—Mr. J. B. Hannay then read a paper on a new method of determining the cohesion of liquids by the size of its normal drop, which he considered was that obtained by allowing the drops to succeed one another as rapidly as possible. He found that the weight of the drop of liquid dropping from a column of the same liquid increases at the rate at which the drops follow one another. This, he thought, was due (1) to the fact that the rate of flow of liquid through the neck of the drop was faster when drops succeeded rapidly, and (2) because the flow lasted for a longer time. He found also that cohesion decreases with rise of temperature, but rather quicker than the density.

Paris

Academy of Sciences, December 31, 1877.—M. Peligot in the chair.—M. Faye presented the *Annuaire du Bureau des Longitudes* for 1878.—The following papers were read:—On the constitution of the solar surface and on photography regarded as a means of discovery in physical astronomy, by M. Janssen. Photography has two advantages over optical observation. If the time of exposure be accurately determined, so as to prevent superposition, or what may be called *photographic irradiation*, the true relations of luminous intensity of the object are expressed. Further, when the luminous action is very short the photographic spectrum is reduced to a narrow band near G; thus very tolerable photographic images of the sun may be had with simple lenses of long focus, and chemical achromatism is much more easily realised than optical. M. Janssen has so arranged that the time of luminous action can be reduced to $\frac{1}{3000}$ of a second in summer. The images are more latent and require slow development, &c. But they throw new light, especially on the solar granulations, which are found more or less of spherical form; the irregular grains are made up of small spherical elements. The state resembles that of our clouds. These spherical elements and their distribution probably result from a breaking up by gaseous currents. The luminous power of the sun, then, resides chiefly in a small number of points of its surface, and the spots are not the principal element of the variations that star undergoes.—Constitution and brecciform structure of the meteoric iron of Santa Catharina (Brazil); deductions from its characters, concerning the history of meteoritic rocks, and especially the habitual association of carbon with sulphide of iron, by M. Daubrée. The association referred to may be explained by the action of sulphide of carbon on iron. If an iron bar be thus treated at a red temperature, it gets coated with a crystalline substance which has the characters of pyrrhotine.—On the order of appearance of the first vessels in shoots of *Fœniculum vulgare* and *dulce*, by M. Trécul.—Note on waves and eddies of various kinds in a canal whose current is alternately intercepted and renewed, and in which the depth can be varied, by M. de Caligny.—On the condensation of gases supposed incoercible, by M. Cailletet. Pure dry nitrogen, compressed to 200 atmospheres at + 13°, then suddenly expanded, condenses distinctly in small droplets; The liquid retires from the walls to the centre. Pure hydrogen compressed to 280 atmospheres and expanded, gave momentarily, a very fine mist. Air was also liquefied by a direct experiment. M. Berthelot corroborated M. Cailletet's account.—M. De Lesseps announced that the *personnel* of the first scientific and hospital station of the International African Association had reached Zanzibar. They had met Stanley and got useful advice from him.—On a storm which occurred over the south part of the Suez Canal on the night of October 23–24. In a few hours an artificial lake of about five million cubic metres was formed on the west side of the canal by the rains.—Kinematics and dynamics of current waves on a liquid spheroid; application to the evolution of the elliptic protuberance about a spheroid deformed by attraction of a distant star, by M. Guyon.—On a new experiment on liquefaction of oxygen, by M. Pictet. The oxygen jet in the electric light showed a white central part (of liquid or even solid elements) and an exterior blue part, indicating return to the gaseous state.—On a note by M. Boussinesq on conditions with limits in the problem of elastic plates, by M. Levy.—On a theorem of M. Villarceau; remarks and consequences, by M. Gilbert.—On a new kind of bird of nocturnal prey from Madagascar, by M. Milne-Edwards. This belongs to the same zoological type as the white owls, but has osteological peculiarities.—The peripheric organs of the sense of space, by M. Cyon. Having shown that there are intimate relations between the semicircular canals and the centres of innervation of the muscles of the eye, he considers that sensations caused by excitation (through the otoliths) of the nerve terminations in the ampullæ of these canals, through movements of the head, serve to form our notions of the three dimensions of space.—On the evolution of red corpuscles in the blood of superior animals, viviparous vertebrates, by M. Hayem. The red corpuscles are developed from small, colourless, delicate, very alterable elements termed *hæmatoblasts*.—Experiments proving that there is during life a figured ferment in typhoid human blood, by M. Feltz.—On the cause of spontaneous alteration of eggs; reply to a reclamation of M. Gayon, by MM. Bechamp and Eustache.

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